SCIENCE

FRIDAY, AUGUST 11, 1916

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

RECENT PROGRESS IN OUR KNOWLEDGE OF THE PHYSIOLOGICAL ACTION OF ATMOSPHERIC CONDITIONS[1]

Two weeks ago to-day, in the physiological laboratory of the Columbia School of Medicine, Dr. Fred W. Eastman and I made the following experiment: A young man, twenty-one years of age, in excellent physical condition, who was willing to act as the subject of our tests, was dressed in light underclothing and light trousers, a sweater, stockings and shoes. His systolic and diastolic blood pressures and his pulse rate were taken in the sitting posture; the carbon-dioxide content of the alveolar air of his lungs was determined; a pneumograph was attached to his chest for recording his respiratory movements; a resistance thermometer was placed in the rectum and connected with a self-writing galvanometer for the continued record of his bodily temperature; and a flat-bulbed thermometer was strapped firmly to his forehead to serve as an indicator of the temperature of his skin. Thus equipped he entered a small chamber, provided with a door and windows and with facilities for heating and humidifying the air. He remained there, sitting quietly, for a period of four and one quarter hours. The temperature of the air in the chamber was raised as quickly as possible above the temperature of his body and reached a maximum of 43.3° C. (110° F.) with a maximum wet-bulb reading of 37.2° C. (99° F.), while the relative humidity was increased to a maximum of 85 per

[1] Read before the American Pediatric Society, Washington, D. C., May 8, 1916.

cent. For a period of two and one quarter hours the door of the chamber was kept closed, although it was not wholly air-tight, and the unusual atmospheric conditions were maintained, although not continually at their maximum. Afterward the door of the chamber was opened and the air within was allowed to acquire the more comfortable conditions of the room air outside, which possessed a temperature of 18° C. (64.5° F.) and a relative humidity of 51 per cent. During the whole time of the experiment a continuous record was made of the subject's bodily temperature; at intervals of fifteen minutes measurements were made of the temperature and the humidity of the air of the chamber, of the temperature of the subject's mouth and of the skin of his forehead, and of the rate of his pulse and his respiration; at intervals of every hour his systolic and diastolic blood pressures and the carbon dioxide content of his alveolar air were determined; while occasional records were made of the carbon dioxide content of the air of the chamber and of the subject's sensations. The results of the experiment will be discussed later. It is typical of many experiments, similar in object although differing in details, which have been performed in recent years inside and outside many laboratories in an endeavor to discover the relations of the individual to the air that surrounds him.

As one result of these experiments there has been a great change in our ideas concerning the physiological action of atmospheric conditions. It had long been the custom to ascribe to chemical components of the atmosphere the bad effects of living in air that had already been breathed by human beings. The discovery of oxygen and of carbon dioxide early in the last century gave a great stimulus to this notion, and it became firmly fixed in the minds of chemists, physiologists and physicians, as well as the educated masses, that air that had been breathed was vitiated chemically and rendered unfit for human use by the lack of oxygen, the accumulation of carbon dioxide, and the presence of an organic poison of unknown nature. No sooner had this notion become widely accepted than the laboratories began to demonstrate the inadequacy of the supposed proof of the notion, and—to cut a long story short—we now know that, except under very unusual circumstances, the harmfulness of respired air is not due to its chemical components. By respiration oxygen can not be reduced to a deleterious proportion nor can carbon dioxide be produced in deleterious quantity, except under very unusual conditions of living; and the organic poison of respiration has no real existence. The harmfulness of living in confined air is found in certain physical rather than chemical features—the air is too warm, too moist, and too still; and if it has not these physical features it is not harmful.

We all have sat in crowded assemblies; we all have experienced the hot, humid, still days of an American summer. We all know the effects of such air on our sensations—the general bodily discomfort, the sleepiness, the flushed face, the headache, the disinclination to think or to act, the general debility, the longing for relief. But sensations are an inadequate measure of bodily conditions. In what respects is hot, humid, still air harmful? To answer this question we must consult the records of many researches, chiefly on human beings, but partly on animals, that have been undertaken since Hermans,[2] more than thirty years ago, observed that in crowded theaters and churches his own bodily temperature rose. The most recent of these researches is that of the New York State

[2] Hermans, *Arch. f. Hyg.*, I., 1, 1883.

Commission on Ventilation,[3] which has been in progress for the past two and one half years and is not yet completed.

Notwithstanding that man is supposed to be a homothermal organism, there is a certain relationship between his bodily temperature and the temperature of his environment, even under the ordinary conditions of living. This has been shown by the New York Commission, which found that during the months of June and July the rectal temperature of its subjects at 8 A.M., living in their own homes, was conditioned by the average atmospheric temperature of the preceding night. If the night had been warm the bodily temperature in the morning was high; if cool, the bodily temperature was low. The variation of bodily temperature was about 0.55 degrees C. (1 degree F.) for 20 degrees of atmospheric temperature, although it is probable that the degree of variation can be modified by the clothing. The commission further found that, whatever the bodily temperature of its subjects might be at the beginning of an experiment, it was lowered by confinement in an atmosphere of 20° C. (68° F.) and 50 per cent. relative humidity, and raised by confinement at 23.9° C. (75° F.) with the same humidity, or still more by 30° C. (86° F.) with 80 per cent. humidity. The final average bodily temperatures in certain series of observations, where the subjects were confined in the observation chamber for from 4 to 7 hours were as follows:

After 20° C. (68° F.), 50 per cent. humidity, the average bodily temperature was 36.7° C. (98° F.).

After 23.9° C. (75° F.), 50 per cent. humidity, the average bodily temperature was 36.9° C. (98.5° F.).

After 30° C. (86° F.), 80 per cent. humidity, the average bodily temperature was 37.4° C. (99.3° F.).

Haldane[4] and others have shown a greater elevation of bodily temperature in more extreme atmospheric conditions, and have pointed out the accompanying dangers of heat stroke. Eastman and I have seen the temperature of a normal adult man rise 3.3° C. (6° F.) during a stay of three and one quarter hours in an atmosphere averaging 40.4° C. (104.7° F.) in temperature and 95 per cent. in relative humidity. The relation between bodily temperature and external cold has not been so fully studied, but enough is known to warrant the statement that, in normal individuals at least, the bodily temperature can be to a considerable degree controlled by controlling the temperature and the humidity of the surrounding air. It is altogether probable that the same is largely true in febrile diseases.

External temperature exerts likewise a definite effect on the circulatory system. The rate of the heart beat is increased in warm, humid, and decreased in cool, dry air. The New York Commission found the average rate of its subjects confined in an atmosphere of 30° C. (86° F.) and 80 per cent. relative humidity to be 74, and in an atmosphere of 20° C. (68° F.) and 50 per cent. humidity to be 66. Eastman and I have seen the pulse rate increase by 39—from 67 to 106—as the temperature of the air surrounding the subject rose from 23.3° to 43.3° C. (74° to 110° F.) and the humidity from 58 to 90 per cent.

The important and involved topic of the

[3] C.-E. A. Winslow (chairman), D. D. Kimball, Frederic S. Lee, J. A. Miller, Earle B. Phelps, E. L. Thorndike and G. T. Palmer (chief of investigating staff). The results of their investigations have yet been published only in part. For a general presentation of some of the results see *Am. Jour. of Public Health*, V., 85, 1915.

[4] Haldane, *Jour. Hyg.*, V., 494, 1905. Haldane, Pembrey, Collis, Boycott and Cadman, Rep. Dept. Com. on Humidity and Ventilation in Cotton Weaving Sheds, London, 1909 and 1911.

relation of atmospheric conditions to blood pressure I must leave until the abundant data that have been accumulated by the New York Commission have been subjected to a more careful examination than has yet been possible, although it may be said that excessively high temperatures and high humidities are accompanied by an elevation of both systolic and diastolic pressures. A study of the commission's records by one of the various methods for evaluating vascular data seems to reveal another fact of distinct importance. When the human body rises from a recumbent to a vertical position the threatened settling of the blood into the lower parts by gravity, with the resultant deleterious effects, ought obviously to be counteracted. In the healthy person the most expedient way to accomplish this is by means of a vigorous vasomotor mechanism acting to constrict the arterioles and raise the blood pressure. This mechanism is assisted by a quickening of the rate of the heart's beat. If the mechanism be enfeebled from any cause, there may be, along with the change of posture, a lessened rise of blood pressure, or even a fall, and a great increase in the heart rate. A comparison, therefore, of the change in the systolic blood pressure and the change in the rate of the pulse resulting from a change of the position of the body from the horizontal to the vertical gives a clue to the efficiency of the vasomotor mechanism. On this basis Crampton[5] has constructed a scale of percentages of vasotone. In terms of this scale the New York Commission finds that the vasotone diminishes in hot and humid air, and increases as the air becomes cooler and dryer. Thus these results indicate that a distinct vascular benefit follows from exposing the body to a cool dry air.

Atmospheric conditions exert on the respiratory system effects of various kinds. On the rate of respiration a moderate degree of heat and humidity seems to be without effect, but more extreme conditions cause a quickening of the breathing, and this is probably accompanied by more shallow respirations. The more extreme conditions too appear to result in a lowered concentration of carbon dioxide in the air of the pulmonary alveoli, although I can not yet quote actual figures to demonstrate this. The matter, however, is important, since a lowered alveolar carbon dioxide may signify an increased content of hydrogen ions, in other words increased acidity, in the blood. Eastman and I are now investigating this point with much interest.

The mucous membrane of the respiratory tract is markedly affected by atmospheric conditions. This was shown three years ago by Hill and Meucke,[6] and it has recently been quite fully investigated by Miller and Cocks[7] under the auspices of the New York Commission. Exposure to heat causes increased swelling, redness and secretion in the nasal mucosa, and these effects are more marked when the humidity of the air is high. Exposure to cold reverses the effects. When the subject passes from a cool to a hot room and a current of air is played upon the face there occurs a diminution of the swelling and the secretion; but passage from a hot to a cool room with a similar draught results in increased swelling and increased secretion. This latter condition seems to be especially favorable for the development of infectious microorganisms. But the causative relation of the bacteria of the nasal mucosa to "colds" seems to be still in doubt.

The distaste for physical labor which we feel on a hot humid day is a common experi-

[5] Crampton, *New York Med. Jour.*, 98, 916, 1913.

[6] Hill and Meucke, *Lancet*, 1291, 1913.

[7] Miller and Cocks, *Trans. Am. Climatol. and Clin. Assoc.*, 1915.

ence, and it is often interpreted as real inability to work. The New York Commission found, in their experiments with human beings, that, if pushed, the individual is capable of performing as much muscular work in an atmosphere of 30° C. (86° F.) and 80 per cent. relative humidity as in one of 20° C. (68° F.) and 50 per cent. humidity, but that he is not inclined to do so much. The lack of exact knowledge as to what the muscles themselves apart from the nervous system can do under such circumstances induced Scott and myself[8] to investigate the subject on animals. Taking the comfortable condition of 20.6° C. (69° F.) with 52 per cent. relative humidity as our standard, we found that when cats were confined for six hours in a well-ventilated chamber, the air of which was kept at an average temperature of 32.8° C. (91° F.) and an average humidity of 90 per cent., the excised muscles of the animals lost in the length of their working period before exhaustion 11 per cent. and in the total amount of work which they were able to perform 24 per cent. At an intermediate temperature and humidity they lost in an intermediate degree. These results indicate that the distaste for physical labor which is felt on a hot and humid day has a deeper basis than mere inclination—the muscles themselves are actually incapable of performing as much work. We found, moreover, that in the extreme condition the blood lost as much as 6 per cent. of its sugar, and 2 per cent. when the intermediate condition was maintained. There is evidently correlation between decreased blood sugar and decreased muscular power, and we have suggested that a physiological adaptation is here indicated, such that "when it is physiologically fitting that the animal reduce muscular exertion to a minimum, in order that the output of heat may be as low as possible, as in a hot and humid environment, the supply of fuel will be lowered correspondingly."

Little can be said at present regarding the action of atmospheric conditions on the nervous system. The rise of external temperature by dilating the cutaneous blood vessels undoubtedly makes the brain anemic, but it is not certain that variations in such temperature with or without variations in humidity markedly affect the action of the nerve tissues, unless the variations are excessive. The New York Commission, under the lead of Thorndike, has expended much time and effort in endeavors to detect a possible influence of atmospheric variations between moderate limits on the ability to do mental work. The subjects were given such psychological tests as cancelling arithmetical figures, adding figures, mentally multiplying three-place by three-place figures, typewriting, and more complex mental performances which involve choice and judgment. The range of atmospheric variation was from a lower limit of 20° C. (68° F.) and 50 per cent. relative humidity, and an upper limit of 30° C. (86° F.) and 80 per cent. humidity. In some cases the air was quiet, in others it was kept in motion by electric fans. The tests continued for periods of from 4 to 7 hours and in some cases they were repeated for 6 successive days under the same conditions. In neither the young men nor the young women subjects of these tests could there be detected any relation between atmospheric conditions and either the accuracy or the amount of the mental work that was performed. A series of experiments on a larger scale has been instituted, but is not yet completed.

The relation between atmospheric conditions and metabolic phenomena is not yet elucidated. During the summer of 1914 the

[8] Lee and Scott, *Am. Jour. of Physiol.*, XL., 486, 1916.

New York Commission made a partial study of this topic on human beings with the assistance of Mr. H. L. Higgins, then of the Carnegie Nutrition Laboratory. The tests employed included such subjects as total metabolism or total heat production, the metabolism of carbohydrate, and the metabolism of protein. The results were almost wholly negative. They can not, however, be regarded as conclusive. As regards lesser specific changes in metabolic processes, too, little can be said at present. But the facts that external cold increases metabolism, that profound metabolic changes occur in the fevers of infection and that there is some evidence that in hyperthermy produced in other ways than by infections metabolism is altered, lead us to suspect that it may be changed, not only totally but in specific details, with even moderate changes in the surrounding atmosphere. It is difficult to believe that a relationship that is so amply demonstrated for the physical phenomena of the body does not involve also its chemical performances.

A further topic that is inviting is the possible relationship between atmospheric conditions and bacterial infections. Most of the experimental observations that have here been made relate especially to the action of temperature on the course of infections, and it has generally been found that high external temperature with accompanying pronounced increase of bodily temperature checks the progress of infections that are already existing. Somewhat lower temperatures (30°–35° C., 86°–95° F.) on the other hand, seem to favor the multiplication of the bacteria and the advance of the disease. In the experiments of Winslow, Miller and Noble,[9] of the New York Commission, in which rabbits were confined in air of from 29° to 32° C. (84.2° –89.6° F.) there was, in the first three weeks, a distinct decrease in the formation of hemolysins when the animals were compared with control animals kept at lower room temperatures. Similar but less striking results were obtained in the formation of agglutinins.[10] It thus appears that external temperatures up to about 30° C. (86° F.) are unfavorable to the development of immune bodies in the blood. Miller and Noble,[11] of the New York Commission, found, furthermore, that respiratory infections of rabbits with *Bacillus bovisepticum* (snuffles) is favored by the chilling of such animals after they have been accustomed to heat, and some of their results suggest that a change from a low to a high external temperature also predisposes to similar infection. Although Chodounsky[12] obtained only negative results, the weight of the recent experimental evidence favors the view that exposure of the body to cold is favorable to the incidence of acute respiratory disease, and it appears not improbable that the primary seat of this deleterious influence is in the mucous membrane of the upper air passages.

No review of recent progress in our knowledge of the relation of man to the atmosphere would be complete if it failed to take note of the striking observations of Mr. Ellsworth Huntington, which are set forth in his engaging book on "Civilization and Climate."[13] Mr. Huntington made a careful study of the output of industrial workers in various factories in the state of

[9] Winslow, Miller and Noble, *Proc. Soc. Exp. Biol. and Med.*, XIII., 93, 1916.

[10] Winslow, Miller and Noble, *Proc. Soc. Exp. Biol. and Med.*, XIII., 1916.

[11] Miller and Noble, "The Effects of Exposure to Cold Upon Experimental Infection of the Respiratory Tract." Not yet published.

[12] Chodounsky, "Erkaltung und Erkältungskrankheiten," Wien, 1907.

[13] Huntington, "Civilization and Climate," New Haven, 1915.

Connecticut, as determined by their monthly wages for piece work, over a period of four years. He found that the annual course of production was as follows: Low at the beginning of the calendar year, it fell still lower and reached its minimum at about the end of January; through the spring there was a gradual increase in output until June; then a moderate decrease until the end of July; in the autumn an increase to the maximum in November; and then the winter descent to the succeeding January minimum. Production was thus greatest in the spring and the autumn, and least in the winter and the summer. A very similar course was followed by the workers engaged in making electrical apparatus in Pittsburgh; and similar confirmation of the validity of the conclusions, with changes in details, was made by the output of other industrial workers in the southern states and by strength-tests of school children in Denmark. All these data combine to demonstrate that the greatest physical efficiency of the individual is found not during the summer or the winter, but at intermediate seasons. That the same is true also of mental activity is shown by a study of the marks secured by the students at West Point and Annapolis in certain classes, especially mathematics. Of the various climatic features of the different seasons that might be responsible for these seasonal differences in achievement, temperature appears to be the most important. Both physical and mental activity seem to be greatest and most effective, not when extreme summer's heat or extreme winter's cold prevails, but when the body is subjected to an intermediate temperature. After a careful consideration of his many figures Huntington came to the conclusion that the optimum temperature of the outside air for the physical work of human beings is about 60° F. (15.6° C.) and for the mental work about 40° F. (4.4° C.) the greatest total efficiency of the human body culminating at the intermediate point of 50° F. (10° C.).

We have thus seen that the body reacts to changes in atmospheric conditions in manifold ways. The most potent of the atmospheric agencies is undoubtedly temperature, but high temperatures exert greater effects when they are accompanied by high humidity. I have said little of the movement of air, but it should be understood that movement is an important agency, and its share in the physiological phenomena has been studied by the New York Commission. By way of general summary it may be said that when an existing external temperature is fairly comfortable to the individual an elevation of it, especially when such elevation is accompanied by an increase of humidity, is deleterious, and the deleterious effects are more pronounced when the air is stagnant. Deleterious effects resulting from such a combination of atmospheric conditions may be in some degree obviated if the air next the skin be put into motion, but a more effective antidote is a reduction in the temperature of the air, and this may be assisted by a reduction in its humidity. All experimentation and observation go to demonstrate that a moderately cool and moderately dry air in motion constitutes the most physiologically helpful aerial envelope of the body. The customary figure of 70° F. (approximately 21° C.) for the atmosphere in which most persons engage in the ordinary occupations of the living room of a dwelling is too high; a range from 65° to 68° F. (approximately 18°–20° C.) with not over 50 per cent. relative humidity, is undoubtedly better, but even such temperatures are too high when much physical activity occurs. Depending on activity and on more obscure corporeal conditions the same external temperature may feel at one time warm and at

another time cold. The degree of comfort that is felt—which should not be allowed too potent an influence in deciding what one's environmental conditions shall be—depends, moreover, largely on the thickness of the clothing and on habit. It is surprising how readily one's habits in this respect may be altered. Uniformity in conditions should be avoided; too long a continuance of an existing temperature is dulling to the body; there should be not infrequent and marked changes. Artificial ventilating systems should not necessarily be condemned, but should be operated intelligently and may advantageously be combined with window ventilation.

In these days we hear much of "fresh" air and its merits. We have fresh-air funds, fresh-air schools, and fresh-air babies. All are commendable; but while giving to our funds, opening our schools, and putting our babies out of doors, let us clearly understand what constitutes fresh air. The freshness of so-called "fresh" air lies, not in more oxygen, less carbon dioxide, less organic matter of respiratory origin, and the hypothetical presence of a hypothetically stimulating ozone, but rather in a low temperature, a low humidity, and motion. So far as fresh air itself is concerned, there seems to be nothing more mysterious about it than this.

To what extent ought fresh air to be used as a therapeutic agent? Here intelligent experience, and not opinion without experience, is the only guide. That a physician, indeed, should have any article in his creed of therapeutics that is not based on the intelligent experience of somebody is not to be supposed. It can not be denied that where intelligent experience has been applied to the topic of fresh air as a therapeutic agent the use of fresh air has been almost invariably extended. But no one has a right to maintain, therefore, that it is a panacea. Only when it has been tested in a great variety of pathological conditions—and this can be done with entire safety to the patient—will the therapeutic use and limitations of this physiologically significant agent become known.

Frederic S. Lee
Columbia University

THE ORIGIN OF THE PRE-COLUMBIAN CIVILIZATION OF AMERICA

In the whole range of ethnological discussion perhaps no theme has evoked livelier controversies and excited more widespread interest than the problems involved in the mysteries of the wonderful civilization that revealed itself to the astonished Spaniards on their first arrival in America.

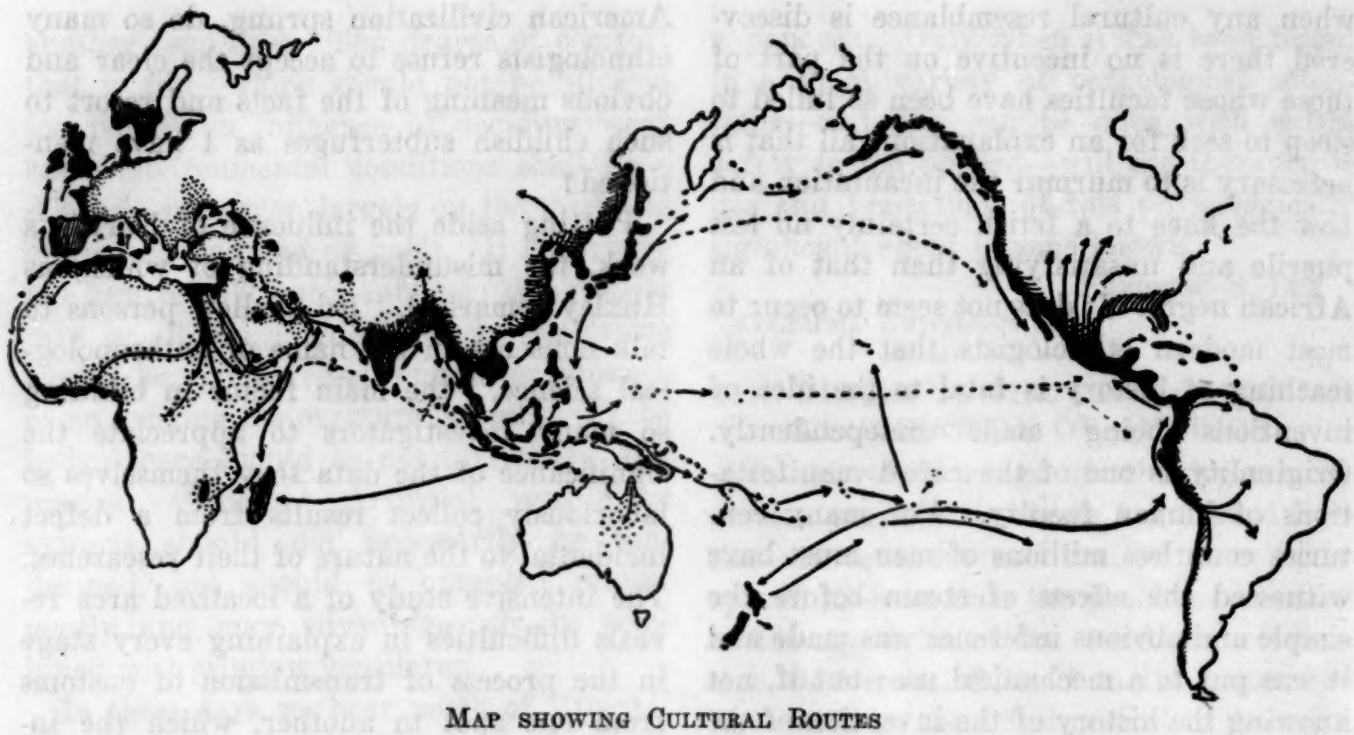
During the last century, which can be regarded as covering the whole period of scientific investigation in anthropology, the opinions of those who have devoted attention to such enquiries have undergone the strangest fluctuations. If one delves into the anthropological journals of forty or fifty years ago they will be found to abound in careful studies on the part of many of the leading ethnologists of the time, demonstrating, apparently in a convincing and unquestionable manner, the spread of curious customs or beliefs from the Old World to the New. Then an element of doubt began to creep into the attitude of many ethnologists, which gradually stiffened until it set into the rigid dogma—there is no other term for it—that as the result of "the similarity of the working of the human mind" similar needs and like circumstances will lead various isolated groups of men in a similar phase of culture independently one of the other to invent similar arts and crafts, and to evolve identical beliefs. The modern generation of ethnologists has thoughtlessly seized hold of this creed and used it as a soporific drug against the need for mental exertion. For

when any cultural resemblance is discovered there is no incentive on the part of those whose faculties have been so lulled to sleep to seek for an explanation: all that is necessary is to murmur the incantation and bow the knee to a fetish certainly no less puerile and unsatisfying than that of an African negro. It does not seem to occur to most modern ethnologists that the whole teaching of history is fatal to the idea of inventions being made independently. Originality is one of the rarest manifestations of human faculty. For many centuries countless millions of men must have witnessed the effects of steam before the simple and obvious inference was made and it was put to a mechanical use; but if, not knowing the history of the invention of the steam engine, we were to adopt the stereotyped ethnological doctrines of the present day the wide geographical distribution of the steam-engine should be regarded as a most striking illustration of the "similarity of the working of the human mind." Nor does it appear to have struck the orthodox ethnologist that his so-called "psychological" explanation and the meaningless phrase "similarity of the working of the human mind" run counter to all the teaching of modern psychology. For it is the outstanding feature of human instincts that they are extremely generalized and vaguely defined, and not of the precise and highly-specialized character which modern ethnological speculation attributes to them. Nor again is the case strengthened by the misuse of the word "evolution," for the independent development of such an artificial confection as civilization postulates the existence of factors utterly alien to the biologist's conception of evolution.

Why then, it will be asked, in the face of the overwhelming mass of definite and well-authenticated evidence clearly pointing to the sources in the Old World from which American civilization sprung, do so many ethnologists refuse to accept the clear and obvious meaning of the facts and resort to such childish subterfuges as I have mentioned?

Putting aside the influence of Darwin's work, the misunderstanding of which, as Huxley remarked, "led shallow persons to talk nonsense in the name of anthropological science," the main factor in blinding so many investigators to appreciate the significance of the data they themselves so laboriously collect results from a defect incidental to the nature of their researches. The intensive study of a localized area reveals difficulties in explaining every stage in the process of transmission of customs from one spot to another, which the investigator is apt to magnify into insuperable obstacles against the view that the practises or beliefs in question did spread. The failure to recognize the fact, recently demonstrated so convincingly by Dr. Rivers, that useful arts are often lost is another, and perhaps the chief, difficulty that has stood in the way of an adequate appreciation of the history of the spread of civilization.

Bearing these considerations in mind and turning to the positive evidence that establishes the reality of the migrations of culture-bearing peoples, it will be found that there is now available a vast mass of precise and unquestionable testimony in substantiation of the conclusion that the curiously distinctive culture-complex which was gradually built up in Egypt between the years B.C. 4,000 and B.C. 900 began to be widely diffused, at some time after the latter date, west, south and east, and that the latter (the easterly migration), with many additions and modifications which it received on the way (in the Soudan, East Africa, and Arabia; in the eastern Mediterranean, Phœnicia, Armenia and Babylonia;



Map showing Cultural Routes

in India, Ceylon, Burma and the Malay Peninsula; in Indonesia and China; and finally in Polynesia) ultimately reached the Pacific coast of the Americas and leavened the aboriginal population of the vast continent with the ferment of the ancient civilizations of the Old World.

During the thirty centuries from B.C. 4,000 onwards there was built up slowly in Egypt, partly as the result of a natural and logical development, but also in part by the accidental addition of many foreign elements, a cultural fabric of a peculiarly complex and artificial texture, the pattern of which is so distinctive that it can be identified wherever and under whatsoever circumstances it occurs.

A people who in B.C. 4,000 were already acquainted with the art of weaving linen, and who practised the curious rite of circumcision, a few centuries later learned to appreciate the usefulness of metals and invented the elements of the metallurgical arts and crafts. It was the merest chance that this particular group of people should have been led by force of circumstances to have been impelled to mummify their dead. But intimately interwoven with the development of the art of embalming and casually related to it was the making of rock-cut tombs and the building of stone superstructures, the possibility of the making of which was suggested by the use of metal tools. The use of linen was also closely related to these developments. Thus the accidental association of a series of naturally disparate factors became welded about B.C. 3,000 into the nucleus of a peculiar culture of which mummification, the making of rock-cut tombs and a great variety of megalithic monuments, the use of copper and gold and the weaving of linen, and the practise of the rite of circumcision, were some of the outstanding features.

In connection with the ritual associated with mummification statues of the deceased were made and a crop of curious beliefs and rites developed. Thus originated the belief in the indwelling of human beings in stones, and the possibility of petrifying men and animals, the rites of incense-burning and offering libations, and a whole series of other bizarre practises and beliefs, which later became so widespread as in

some measure to seem to justify the prevalent conviction that they were independent expressions of a common human instinct.

It was the merest chance that the people amongst whom this remarkable culture-complex was gradually being built up should have been sun-worshipers, and that the particular group amongst whom the royal family of Egypt originated regarded the Horus-hawk as the symbol of their royalty. It was no less fortuitous that the seat of the capital after the first unification of Egypt should have been in a place (Buto) where the uræus-serpent was venerated. Thus there is the clearest evidence that the complex symbolism of the Sun-god—the sun's disc, the serpent and the hawk's wings—is purely a chance association which was established in Egypt. The intimate connection of sun-worship and its peculiar symbolism with megalithic monuments, with mummification, and with the conception of the king as the son of the god are equally fortuitous associations.

It was no less a chance that this distinctive culture-complex was built up amongst an agricultural people who by force of circumstances were expert in a peculiar method of irrigation.

In the times of the New Empire (from B.C. 1,600 onward) a great variety of accidental accretions were made to this complicated type of civilization which for long centuries had been growing up in Egypt. Such practises as piercing the ears, and a remarkable series of new tricks in the embalmer's technique, are examples of the innovations, some of which are so definite as to enable us to state that the type of Egyptian culture-complex which was distributed so widely in the world could not have started on its wanderings before B.C. 900 at the earliest. It was probably at least a century later before the great migration left the African shores.

It reached the Persian Gulf by various routes. The fact that it passed up the Nile, through Nubia and the Soudan, thence by East Africa and the Arabian coast, is proved by a large series of Ethiopian accretions to and modifications of Egyptian practises when they appear in India and farther east. There are historical reasons for believing that a good deal of intercourse took place via the Red Sea and the Arabian littoral.

The transmission of a number of Mediterranean customs, such as the use of pearls, *Purpura* and conch-shell trumpets, and certain peculiar modifications of embalming indicate the influence of the Levant. The use of the Swastika-symbol, the peculiarly distinctive Black Sea type of dolmen, and the Armenian custom of skull deformation, are further tokens of the part taken by western Asia in adding to and modifying the purely Egyptian contributions to the strange cargoes these ancient mariners carried to India. There are also manifold witnesses of the influence of Babylonia, not only in modifying the Egyptian architectural ideas of the wanderers, but also in contributing new ideas and beliefs. An example is the greater definiteness assumed by the story of the creation, the deluge, the destruction of the sons of men by petrifaction, and the perpetuation of the chosen race by incestuous unions.

This cultural stream from the Persian Gulf to the Indian coast probably began at the end of the eighth century B.C. and persisted for many centuries; and the Pre-Aryan population of India became thoroughly leavened with its potent influence. Ceylon and further India, Burma and the Malay Archipelago, in turn were brought within the sphere of its activities, probably as early as the sixth and fifth centuries B.C.

From Indonesia the whole eastern Asiatic littoral and all the neighboring islands were

stirred by the new ideas; and civilizations bearing the distinctive marks of the culture-complex which I have traced from Egypt sprang up in Cochin-China, China, Corea, Japan and eventually in all the islands of the Pacific and the western coast of America. The proof of the reality of this great migration of culture is provided not merely by the identical geographical distribution of a very extensive series of curiously distinctive, and often utterly bizarre, customs and beliefs, the precise dates and circumstances of the origin of which are known in their parent countries; but the fact that these strange ingredients are compounded in a definite and highly complex manner to form an artificial cultural structure, which no theory of independent evolution can possibly explain, because chance played so large a part in building it up in its original home.

For instance, it is quite conceivable (though I believe utterly opposed to the evidence at our disposal) that different people might, independently the one of the other, have invented the practises of mummification, building megalithic monuments, circumcision, tattooing and terraced irrigation; evolved the stories of the petrification of human beings, the strange adventures of the dead in the underworld, and the divine origin of kings; and adopted sun-worship.

But why should the people of America and Egypt who built megalithic monuments build them in accordance with very definite plans compounded of Egyptian, Babylonian, Indian and East Asiatic models? And why should the same people who did so also have their wives' chins tattooed, their sons circumcised, their dead mummified? Or why should it be the same people who worshiped the sun and adopted the curiously artificial winged-sun-and-serpent symbolism, who practised terraced irrigation in precisely the same way, who made idols and held similar beliefs regarding them, who had identical stories of the wanderings of the dead in the underworld?

If any theory of evolution of customs and beliefs is adequate to explain the independent origin of each item in the extensive repertoire, either of the New Empire Egyptian or the Pre-Columbian American civilization (which I deny), it is utterly inconceivable that the fortuitous combination of hundreds of utterly incongruous and fantastic elements could possibly have happened twice. It is idle to deny the completeness of the demonstration which the existence of such a civilization in America supplies of the fact that it was derived from the late New Empire Egyptian civilization, modified by Ethiopian, Mediterranean, West Asiatic, Indian, Indonesian, East Asiatic and Polynesian influences.

The complete overthrow of all the objections of a general nature to the recognition of the facts has already been explained. There is nothing to hinder one, therefore, from accepting the obvious significance of the evidence.

Moreover, every link in this chain of connections is admitted by investigators of localized areas along the great migration route, even by those who most strenuously deny the more extensive migrations of culture.

The connections of the New Empire Egypt with the Soudan and with Syria and its relations with Babylonia; the intercourse between the latter and India in the eighth and seventh centuries B.C.; the migrations of culture from India to Indonesia and to the farthest limits of Polynesia—all these are well authenticated and generally admitted.

All that I claim, then, is that the influence of Egypt was handed on from place to place; that the links which all ethnologists recognize as genuine bonds of union can

with equal certainty be joined up into a cultural chain uniting Egypt to America.

In almost every one of the focal points along this great migration route the folklore of to-day has preserved legends of the culture-heroes who introduced some one or other of the elements of this peculiarly distinctive civilization.

Those familiar with the literature of ethnology must be acquainted with hundreds of scraps of corroborative evidence testifying to the reality of the spread postulated. For I have mentioned only a small part of the extraordinary cargo of bizarre practises and beliefs with which these ancient mariners (carrying of course their characteristic ideas of naval construction and craftsmanship) set out from the African coast more than twenty-five centuries ago on the great expedition which eventually led their successors some centuries later to the New World.

At every spot where they touched and tarried, whether on the coasts of Asia, the islands of the Pacific or on the continent of America, the new culture took root and flourished in its own distinctive manner, as it was subjected to the influence of the aborigines or to that of later comers of other ideas and traditions; and each place became a fresh focus from which the new knowledge continued to radiate for long ages after the primary inoculation.

The first great cultural wave (or the series of waves of which it was composed) continued to flow for several centuries. It must have begun some time after B.C. 900, because the initial equipment of the great wanderers included practises which were not invented in Egypt until that time. The last of the series of ripples in the great wave set out from India just after the practise of cremation made its appearance there, for at the end of the series the custom of incinerating the dead made its appearance in Indonesia, Polynesia, Mexico and elsewhere.

In asking you to publish this crude sketch of views which I have set forth in greater detail elsewhere[1] I wish especially to appeal to that band of American ethnologists, whose devoted labors in rescuing the information concerning the ethnography of their country have called forth the admiration of all anthropologists, seriously to reconsider the significance of the data they are amassing.

G. ELLIOT SMITH

THE PRODUCTION OF TUNGSTEN

THE tungsten production of the United States during the first six months of 1916 exceed the production of this or any other country in any previous twelve months. Prices were even more phenomenal than production and reached more than ten times their ordinary level. The output was equivalent to about 3,290 short tons of concentrates carrying 60 per cent. WO_3, valued at $9,113,000, according to an estimate made by Frank L. Hess, of the United States Geological Survey, Department of the Interior. Statistics are valuable only so far as their accuracy is known, and this estimate is believed to be correct within 10 per cent. and to be under rather than over the true figures.

These figures are no less noteworthy when it is known that in 1915 much the larger part of the production was in the second half of the year, so that the total domestic output for the twelve months ending June 30, 1916, probably amounted to about 5,000 tons.

Colorado has regained its lead in the production of tungsten ores and, between January 1 and June 30, marketed 1,505 tons, valued at $3,638,000, of which the Boulder field furnished 1,494 tons. California sold 984 tons, valued at $3,005,000. The reason for the higher value of the California ore was that it

[1] "The Significance of the Geographical Distribution of the Practise of Mummification," now being published in the *Memoirs* of the Literary and Philosophical Society of Manchester.

was nearly all sold as high-grade concentrates, but a large part of the Colorado ore sold was of low percentage and had to be milled and concentrated, with consequent expense and loss.

From Nevada 461 tons, valued at $1,432,000, and from Arizona 175 tons, worth $565,000, are estimated to have been shipped. Smaller quantities were mined in Alaska, Connecticut, Idaho, Missouri, New Mexico, South Dakota, Utah and Washington.

Not only were the output and prices unique, but the ratio of the several tungsten minerals produced was different from that of other countries of large production. The quantities and values were approximately as follows: Ferberite, 1,495 tons, $3,590,000; scheelite, 1,404 tons, $4,322,000; wolframite, 201 tons, $613,000; and hübnerite, 185 tons, $587,000.

In most countries the prevailing mineral is wolframite, and no other country approaches the United States in the quantity of ferberite or scheelite produced. The scheelite comes mostly from Atolia, Calif., but significant quantities are mined in Nevada, Arizona, Idaho and Connecticut.

The tremendous increase of prices caused by the need for "high speed" tools to cut war steel ordered by the governments of Europe of course caused the great increase in production. Prices at the beginning of the year were irregular and depended on the buyer's need of the ore and probably on his fear of the possibility of not being able to get it when he might need it even more. Ores carrying 60 per cent. tungsten trioxide brought at that time as much as $66 a unit, but by the last of March some ferberite sold for $93.50 a unit at the mills, and even higher prices were quoted in the newspapers, though they could not be confirmed. The prices of the same ore in the New York market would naturally be somewhat higher. Under the stimulus of these high prices production, not only in this country but in the world at large, has been at the highest point ever known. At first the sudden demand created by the orders for war steel were far ahead of the instant productive power of the country. The rapid increase in prices, starting last fall at a time when tungsten mining was at a low ebb and culminating in the undreamed maximum mentioned, caused prospecting and consequent discoveries of new deposits, increase of development of known deposits, the operating at high tension of old mills, and the hasty building of new mills. As a result, the production increased faster than the consumption and soon overran the demand that would absorb the output at the extremely high prices prevailing, so that a drop in prices was inevitable. June closed with the price around $25 a unit, which was still much higher than any price known before this year. The highest price previously reported to the Geological Survey was $15 a unit, paid in 1907. The normal price has been $6 to $7.

During the six months under consideration 40 mills of various types and sizes were in operation part or all of the time on tungsten ores, and, at the end of June, 14 were under construction.

In the tungsten mining camps the excitement that followed the increase of prices was similar to that caused by important gold discoveries. Nederland, Colo., a little village of two or three dozen homes, suddenly became a town of 3,000 or more inhabitants. East of Nederland two settlements, each containing several hundred people, sprang into existence. Atolia, Calif., a camp of 60 or 80 people, grew to more than a thousand.

SCIENTIFIC NOTES AND NEWS

The Paris Academy of Sciences on June 26 elected as corresponding members Dr. Ramon y Cajal of Madrid to fill the place of M. Perez in the section of anatomy and zoology, and Dr. Morat, professor of physiology at Lyons, to succeed Dr. Zambaco Pasha in the section of medicine and surgery.

Dr. E. Perroncito, professor of bacteriology at the University of Turin, and Professor Kitasato, director of the bacteriologic institute at Tokyo, have been elected foreign members of the Paris Academy of Medicine.

Professor Hugo de Vries, professor of the University of Amsterdam and director of the Botanical Garden, has removed his residence to Lunteren, where he is building a small

private laboratory in connection with an experimental garden. Professor de Vries must by law retire from his professorship at Amsterdam within two years and plans to continue his experimental researches at Lunteren.

A. A. STEVENSON, Philadelphia, has been elected president, and S. S. Voorhees, Washington, D. C., vice-president, of the American Society for Testing Materials.

DR. ALFRED E. CAMERON, formerly of the department of agricultural entomology, University of Manchester, has taken up duties in the entomological branch, Department of Agriculture, Ottawa, Canada.

PROFESSOR R. P. STRONG, of the Harvard Medical School, has been visiting the American camps in Mexico to study their sanitary condition.

DR. CHAS. H. HERTY, professor of chemistry and dean of the School of Applied Science of the University of North Carolina; Dr. W. R. Whitney, director of the research laboratory of the General Electric Company, Schenectady, N. Y.; Dr. Leo H. Baekeland, of Yonkers, N. Y., and Warren K. Lewis, of Newton, Mass., have been appointed by the American Chemical Society to cooperate with the committee of the National Academy of Sciences on the nitrate supply for the United States government.

THE president of Cuba issued a decree on July 3, creating a plant quarantine and inspection service under the name Comisión de Sanidad Vegetal. The commission is composed of John R. Johnston, pathologist of the Estacion Experimental Agronomica as president; Mario Sanchez Roig, professor of natural history in the Agricultural School of Havana, as secretary, and Patricio Cardin, entomologist of the Estacion Experimental Agronomica. Three field inspectors have been appointed, one to attempt control of the spiny white fly of citrus, one to begin the "sanitation" of the coconut groves on account of the budrot, and the third to clean up the banana plantations affected by the Panama disease. In addition to the attempt at control of these most serious plagues, the commission will also have in charge the arrangements for quarantine regulations affecting the importations and exportations of plants.

AT the conference on infantile paralysis held last week in New York, Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute, was elected to preside, and two committees were appointed. One, which is to study laboratory methods, is made up of Dr. Ludwig Hektoen of the University of Chicago, Dr. Hans Zinsser, professor of bacteriology in the College of Physicians and Surgeons; Dr. Richard M. Pearce, Jr., professor of research medicine in the University of Pennsylvania; Dr. J. W. Jobling of Vanderbilt University, Dr. G. W. McCoy of the Government Hygienic Laboratories in Washington, and Dr. Theobald Smith of the Rockefeller Institute. The members of the second committee, which is to study methods of prevention, are Dr. Victor C. Vaughan of the University of Michigan, Dr. M. J. Rosenau of Harvard, Dr. William H. Park of the New York Health Department Laboratories, Dr. Francis W. Peabody of the Peter Brent Brigham Hospital in Boston, Dr. John Howland of Johns Hopkins University, Dr. Augustus Wadsworth of the State Health Department, and Dr. Charles C. Bass of Tulane University, New Orleans.

THE British prime minister has appointed, as we learn from *Nature*, a committee to consider the commercial and industrial policy to be adopted after the war, with special reference to the conclusions reached at the economic conference of the allies, and to the following questions: (*a*) What industries are essential to the future safety of the nation; and what steps should be taken to maintain or establish them. (*b*) What steps should be taken to recover home and foreign trade lost during the war, and to secure new markets. (*c*) To what extent and by what means the resources of the Empire should and can be developed. (*d*) To what extent and by what means the sources of supply within the Empire can be prevented from falling under foreign control. The committee is composed as follows: Lord Balfour of Burleigh (chairman), Mr. Arthur Balfour, Mr. H. Gosling, Mr. W. A. S. Hewins, M.P., Mr. A. H. Illingworth, M.P., Sir J. P. Maclay,

Sir A. Mond, M.P., Mr. Arthur Pease, Mr. R. E. Prothero, M.P., Sir Frederick H. Smith, Mr. G. J. Wardle, M.P., together with the following gentlemen, who are presiding over the Board of Trade committees on the position of important industries after the war: Sir H. Birchenough, Lord Faringdon, Sir C. G. Hyde, Sir C. A. Parsons, F.R.S., Lord Rhondda and Mr. G. Scoby-Smith. Mr. Percy Ashley, of the Board of Trade, and Mr. G. C. Upcott, of the Treasury, have been appointed secretaries to the committee.

The trustees of the Beit fellowships for scientific research, which were founded and endowed three years ago by Mr. Otto Beit, in order to promote the advancement of science by means of research, have elected to fellowships for 1916–17: Mr. H. N. Walsh, Cork (extension for a second year); Mr. W. A. Haward, Tufnell Park, and Mr. C. C. Smith, Bristol. The three fellows will carry on their researches in the Imperial College of Science and Technology, London.

Messrs. A. J. Grove and L. Harrison have been appointed by the British War Office to advise on entomological problems in connection with the military operations in Mesopotamia. The services of Dr. W. A. Lamborn have been lent by the Imperial Bureau of Entomology to the War Office and he is now attached to the expeditionary force in East Africa.

According to a cablegram from England Lieutenant Sir Ernest Shackleton has again failed to rescue the main body of his Antarctic expedition left on Elephant Island and has returned to the Falkland Islands. Sir Ernest returned on board the steamer *Emma* from Port Stanley. The ship was forced back by heavy gales and ice and it was found impossible to get near Elephant Island through the pack ice. The ship was battered, the engines were injured and the *Emma* was obliged to proceed under sail. Sir Ernest, the correspondent adds, recognizes that it is useless to attempt to force a passage with a light ship and he is waiting for the steamer *Discovery* to come from England.

Professor Samuel Wendell Williston, of the department of geology and paleontology of the University of Chicago, has given four lectures on the afternoons of August 1 to 4 inclusive, the subjects of the separate lectures being: "The Earliest Land Animals—Amphibians," "The Earliest Land Animals—Reptiles," "The Evolution of Reptiles" and "The Evolution of Mammals."

The death, at the age of fifty-three years, is announced of Elton Fulmer, professor of chemistry and dean of the faculty in the Washington State College at Pullman.

Frederick William Frankland, associate actuary for the Equitable Life Assurance Society, died on July 26 at his home in New York City. He was a son of the late Sir Edward Frankland, and was born in Manchester, England, sixty-three years ago. Mr. Frankland came to this country nine years ago, and was for some years connected with the New York Life Insurance Company. He had written many papers on mathematical, metaphysical and sociological subjects.

Dr. Rowland Cox, Jr., of Paterson, N. J., who was for seven years instructor in operative surgery in the College of Physicians and Surgeons, Columbia University, has died in his forty-fifth year.

The death is announced of Ludwig Siegmund Albert Neisser, professor of skin and venereal diseases at the University of Breslau, one of the distinguished German pathologists. He was born sixty-one years ago at Breslau, where his father was a physician, who translated several American works into German, including G. M. Beard's "Neurasthenia."

The secretary of war has submitted a supplemental estimate of appropriation of $7,000,000 required for the service of the fiscal year, 1917, by the medical and hospital department for the medical needs of an active military force of 400,000 men, in addition to amounts heretofore estimated for such purpose.

Announcement is made that the Psychopathic Clinic for Mentally Deranged and Feebleminded Persons at the State Prison,

Sing Sing, has received an endowment of $10,000 from John D. Rockefeller. The clinic was opened on August 3, and the advisory board is composed of Drs. Terry M. Townsend, George S. Burns and William Seaman Bainbridge.

THE *Journal* of the American Medical Association notes that an anonymous donor has offered a prize of $10,000 to be handed over to the maker of the mechanical apparatus best supplying the place of the hand. All competitors must belong to allied or neutral nations. They are to demonstrate before the French Surgical Association mutilated men who have been using their apparatus for at least six months. The surgical association will experiment with each apparatus on mutilated men for the length of time it thinks fit. The apparatus rewarded is to remain the property of its inventor. The competition will be closed two years after the end of the war. Any person wishing to compete should write M. le Secrétaire Général de la Société Nationale de Chirurgie, 12, rue de Seine, Paris, France.

THE Mary Murdoch Memorial Loan Fund has been raised to perpetuate the memory of Dr. Mary Murdoch, of Hull, her high professional standard and the inspiration and encouragement she was to her colleagues and friends. The committee which has been formed to administer the fund is prepared to grant loans of £100 or less, free of interest, so as to give women doctors some financial help at a time when they may specially need it. Such special need might be during their early years of establishment in practise, to enable them to study some special subject or purchase some particular apparatus, etc. This fund will be open to all medical women, but preference will be given to those who have been trained at the London School of Medicine for Women, which was Dr. Murdoch's school.

PRESENTING a report on the year's work at Commemoration Day at King's College, the principal, Dr. Burrows, said that regular men students of English birth had fallen from over 800 in the year previous to the war to a little over 100. The college had contributed 512 officers to the army and navy. Fifty-seven students had lost their lives. Twenty-one members of the staff were on war or munition service, three of whom held the rank of lieutenant-colonel. On the science side every laboratory in the college was being worked in the service of the government. Professor Jackson, in the chemistry department, had solved the formulæ for making all the delicate kinds of glass, including miners' safety lamps, which had hitherto been made in Germany and Austria. Professor Bottomley was still engaged on his researches on bacterized peat, which, it was hoped, would effect a revolution in the treatment of poor soil. The department of engineering had devoted itself to the training of unskilled labor for munition factories.

THE Hawaii National Park, just created by Congress, is the first national park lying outside the continental boundaries of the United States. It sets the three Hawaiian volcanoes, Kilauea, Mauna Loa and Haleakala, and entrusts their protection and development to the Department of the Interior. "The Hawaiian volcanoes," writes T. A. Jaggar, director of the Hawaiian Volcano Observatory, "are truly a national asset, wholly unique of their kind, the most famous in the world of science and the most continuously, variously and harmlessly active volcanoes on earth. Kilauea crater has been nearly continuously active with a lake or lakes of molten lava for a century; Mauna Loa is the largest active volcano and mountain mass in the world, with eruptions about once a decade, and has poured out more lava during the last century than any other volcano on the globe. Haleakala is a mountain mass 10,000 feet high, with a tremendous crater rift in its summit eight miles in diameter and 3,000 feet deep, with many high lava cones built up inside the crater. It is probably the largest of all known craters among volcanoes that are technically known as active. Haleakala erupted less than 200 years ago. The crater at sunrise is the grandest volcanic spectacle on earth."

VAN H. MANNING, director of the Bureau of Mines of the Department of the Interior, will

visit the University of Washington in the near future to determine whether it shall have the mining experiment station to be established in the northwest. Congress recently authorized the establishment of ten of these stations. One has already been established at Fairbanks, Alaska, and another is to be located in one of the North Pacific states. The University of Washington has asked that this station be located here. It is pointed out that Seattle is ideally located for the North Pacific station, and that the university with its school of mines, is well equipped to do the scientific research and experimental work that will be required. While the University of Washington's request for the station has the endorsement of the senators and representatives it is meeting with some opposition. The University of Idaho, at Moscow, is also anxious to obtain the station, and the Montana delegation in congress favors Idaho. The chief work of the stations will be to find ways and means for the profitable handling of low grade ore. Each station will be given $25,000 annually by the federal government for the establishment and maintenance of the station.

Some time ago the British government appointed a committee of the privy council for scientific and industrial research, so as to coordinate science with industrial work. When the White paper elaborating the proposed researches of the committee reached Mr. Hagelthorn, then minister for public works of the Australian Commonwealth, he suggested that the operations of the committee should be imperial in scope, and not limited to Great Britain. With this view the prime minister (Mr. Hughes) agreed, and at once constituted a Science Congress, which has had several meetings, and has submitted a report to the Commonwealth government. The suggestion of Mr. Hagelthorn was brought under the notice of the Secretary of State for the colonies, and a reply has been received agreeing that the committee of the privy council should be given a wider scope, and it will therefore include the empire on all questions that extend beyond the boundaries of Great Britain or the special dominions. Mr. Hughes has been in consultation with the committee of the privy council since he has been in London, and on his return the work of the Science Congress in Australia will be coordinated with that of the committee of the privy council.

In the forty-seventh annual report of the American Museum of Natural History, President Henry Fairfield Osborn lays stress upon the urgent need of the institution for more space. No building has been added since the erection of the southwest wing under the law of 1905, while the collections have doubled in extent, important educational departments have been opened, available space in the present building is crowded to capacity, and the scientific and educational value of some of the finest collections in the world is lost for lack of a building in which to house them. The estimated cost of the proposed new southeast wing and court building is $750,000. It will provide space for the collections of mammals of the sea and fauna of Europe and Asia; for the splendid collections of existing fishes and reptiles, now crowded away in the dark and out of sight; for the superb collection of whales hitherto not exhibited; for other collections, and for offices, laboratories and storage room which are seriously needed. Since it seems possible that the finances of New York City will not permit of the building of this extension in the near future, the question is being considered by the trustees of the museum as to the advisability of raising funds for the new wing by private subscription and solving in this way a problem that is rapidly reaching a crisis.

The medical committee of the British Science Guild, under the chairmanship of Sir Ronald Ross, passed, as we learn from *Nature*, the following resolutions at a recent meeting: (1) The medical committee of the British Science Guild views with disfavor the suggestion that has been made by certain district councils to cease watering the streets as a war economy, and is convinced that such a step would be prejudicial to the public health. (2) The medical committee also views with great disfavor the pollution of the streets of London, and of most cities and big towns, by dogs, and

considers that the attention of the government and of municipalities should be called to the possibility of reducing the evil by increasing the tax on dogs and by enforcing by-laws. The committee considers that in towns the tax on one dog should be doubled and a large progressive increase imposed on each additional dog.

THE Henry S. Upson Foundation has been organized in Philadelphia for the purpose of encouraging the systematic study of problems wherein dental pathologic conditions are correlated with those of internal medicine, surgery, neurology and psychiatry. The late Henry S. Upson, professor of neurology in the Western Reserve University, had been for years deeply interested in the subject, and the foundation has been endowed by Mrs. Upson as a memorial to her husband. The organization is composed of a commission, the members consisting of Drs. Edward C. Kirk, chairman, J. Madison Taylor, Charles E. deM. Sajous, Nathaniel Gildersleeve, Hermann Prinz and Arthur Hopewell-Smith. This commission elected an executive committee consisting of three members of the commission—namely, Dr. Edward C. Kirk, chairman, Dr. J. Madison Taylor, secretary, and Dr. Nathaniel Gildersleeve. This committee selected a board of associate experts in lines which include the more cognate subjects, consisting of Dr. De Forrest P. Willard, orthopedist; Dr. Wendell Reber, ophthalmologist; Dr. Morris Piersol, internist; Dr. Charles R. Turner, prosthetist; Dr. M. H. Cryer, oral surgeon; Dr. John V. Mershon, orthodontist; Dr. S. D. W. Ludlum, neurologist; Dr. Ralph Butler, rhinologist and laryngologist, and Dr. Edward Schuman, pediatrist.

UNIVERSITY AND EDUCATIONAL NEWS

THE vocational-educational bill, providing for federal cooperation with the states in promoting agricultural and industrial education, makes an annual appropriation beginning at $500,000 and increasing each year by $250,000 until $3,000,000 is reached, to be apportioned to the states in proportion to their rural population.

THE trustees of the University of Indiana have recommended that a new medical school building, power house, laundry and nurses' home be erected on the grounds of the Robert W. Long Hospital, Indianapolis. A committee was appointed, including the president of the university, Drs. Samuel Smith, Richmond; Charles P. Emerson, John H. Oliver and Frank F. Hutchins, Indianapolis, to formulate plans for the proposed building and report to the board.

LORD CREWE at a meeting of the governing body of the Imperial College of Science and Technology, speaking, on June 30, of the professor's memorial on the neglected teaching of science, said that the government intended to appoint a committee of scientific men to inquire into the position of natural science in the English educational system, especially in the universities and secondary schools.

DISCUSSION AND CORRESPONDENCE

MOSQUITOES AND MAN

IN SCIENCE for June 2, 1916, p. 784, Dr. C. S. Ludlow calls attention to the association with man of those species of mosquitoes concerned in disease transmission, laying particular stress upon *Anopheles* and malaria. This is an important factor in epidemiology all too frequently overlooked by the sanitarian, but it is surprising to find that Dr. Ludlow claims for Major P. M. Ashburn, as indeed he does for himself, the discovery of this relation.

The fact is, this relationship has been long recognized by careful students. Its consideration unquestionably led Finlay to his deduction as to the transmission of yellow fever, the truth of which was afterward so thoroughly demonstrated by the American Army Commission.

In the case of malaria, Grassi was led to the discovery of the Anopheline host by similar considerations. He attacked the problem from the ecological viewpoint, eliminating those blood-sucking forms which did not coincide with the disease in distribution. This is really only a different formulation of the same idea.

India has probably produced a larger num-

ber of careful investigators of malaria and *Anopheles* than any other region. The fact that certain species of *Anopheles* occurred only in proximity to man, while others were "wild" was appreciated as early as 1902 and 1903 and it is set forth in the classic "Monograph of the *Anopheles* mosquitoes of India," by James and Liston (1904). A single brief quotation from Stephens and Christophers will be sufficient to demonstrate this.

> *Anopheles rossii* was found by us always near human dwellings, and often in very foul water. In spite of this commonness of the species, larvæ were never found more than a stone's throw from dwellings. If in any place larvæ were discovered at a greater distance, they invariably turned out to be the larvæ of other species. *A. rossii* appears, then, in Bengal to be "foveal" in its distribution, in contradistinction to other species of *Anopheles* to be described.[1]

This difference in habits of the different species of *Anopheles* is generally recognized among workers in India, and one finds frequent allusions to it in their writings.

In Africa, a similar tendency on the part of certain species of *Anopheles* to associate with man has been noted and a number of authors could be cited in demonstration.

In America, the interrelation, at least in connection with malaria, seems to have been recognized rather tardily. Knab enunciated and discussed it in a series of papers published during 1912 and 1913 (1, 2, 3, 4, 5).

His deductions were based, he asserts, upon observations made by the writer in the Panama Canal Zone. The adaptation was indicated very clearly in discussing *Anopheles albimanus,* precisely the species, it is interesting to note, which also impressed Major Ashburn. I quote from the original statement.

> While not domestic in the same sense as *Stegomyia calopus, Anopheles albimanus* is closely associated with man and finds its most congenial surroundings about his habitations and in the conditions he creates in the course of agricultural, engineering and other work. This fact is correlated with the highly developed blood-sucking habit and has been an active factor in its development and in establishing the economic importance of the species (6).

The same relation of *Anopheles albimanus* toward man was observed by another worker in the Panama Canal Zone, James Zetek, and discussed in a paper published in 1915.

Quoting briefly:

> The writer in his inspection of the Canal Zone, found *A. albimanus* to breed only near settlements. It therefore seems quite plausible to believe that the pathogenic species of *Anopheles* become more and more restricted to human settlements, an adaptation which no doubt will hold for all animals which play a rôle similar to that of *albimanus* in the transmission of disease (10).

But too sweeping claims regarding the adaptation of the malaria-transmitting *Anopheles* should not be made. The writer, as quoted above, has already indicated that the association with man is a much looser one than in the case of *Ædes calopus,* and, it should be added, *Culex quinquefasciatus* (*fatigans*). Knab points out that the long period during which the malarial gametes are present in the human circulation effectively compensates for less frequent opportunity for infection of the mosquito. Dr. Adolph Lutz of Brazil even goes so far as to condemn altogether the idea of adaptation in the case of *Anopheles* (7, 8).

He asserts that in Brazil, *Anopheles albimanus* occurs in uninhabited localities. Nor will he admit any predilection for man on the part of this mosquito, since he has observed that it prefers the horse to the rider (l. c.). In fact, no such predilection has been demonstrated for any *Anopheles,* except, perhaps, it can be inferred in the case of the Indian *Anopheles rossii.* That it does not exist in the European *Anopheles maculipennis,* which unquestionably has had all possible opportunity to develop such a taste, has been very clearly shown by Mühlens (9). Grassi and others have gone on record that the degree of attraction depends upon the size of the animal, a man being preferred to a dog, a horse or cow to a man.

This much must be admitted in any case; that the highly developed appetite for blood of certain species of *Anopheles* and frequent op-

[1] Reports to the Malaria Committee of the Royal Society, London, 6th Series, p. 15, 1902.

portunities to satisfy that appetite from the same host, man, has made the malarial relation possible.

The important malaria transmitters are to be found among the most bloodthirsty species, and such species will mutiply rapidly in the presence of an abundant food-supply, as when laborers are massed at some previously uninhabited point. That there will be a corresponding decrease in these *Anopheles* when the food-supply is removed goes without saying.

Returning to the conditions in India, it is interesting to note that the most "domestic" species of *Anopheles rossii,* already indicated in the foregoing, is not a malaria transmitter. The most important transmitters are species normally breeding at a distance from human habitations and showing no special "domesticity." They have, however, a very highly developed appetite for blood, and this, in spite of their very much smaller numbers, makes them most effective transmitters of the malarial parasites.

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ALLAN H. JENNINGS
U. S. BUREAU OF ENTOMOLOGY

GOITER AMONG THE INDIANS ALONG THE MISSOURI

THE writer would like to call the attention of those interested to the excessive prevalence of goiter and symptoms of thyroid derangement among the Indians along that part of the Missouri Valley comprised between the Cannon Ball Creek and Cheyenne River, in North and South Dakota. The prevalence and relative acuteness of these conditions are such as to demand some special steps for their control or relief, and invite a thorough local investigation of conditions by specialists or institutions.

The people in question are the Cheyenne River and Fort Yates Sioux, and were visited by the writer last April. The frequency of goiter among the Cheyenne River bands ("Blackfeet" and "Two-Kettle") has been known for many years. In 1908, on the occasion of the writer's report on various diseases among the Indians,[1] they were in that respect at the head of the column, with 61.4 cases of goiter per thousand population, compared to 3 per thousand for the U. S. Indians as a whole. But the present extent and the equally great or even greater frequency of the disease in certain parts of the Fort Yates territory have not been suspected.

The writer examined in the two localities mentioned between 400 and 500 children and adults. The examinations were for anthropological purposes, and no record was kept of the exact proportion of thyroid enlargements; but the subject soon forced itself upon his attention. Case after case was met, particularly

[1] Hrdlička, Aleš, "Physical and Medical Observations among the Indians of Southwestern U. S. and Northern Mexico," p. 201.

among the adults, in which the pulse was excited, the heart enlarged and the temperature slightly above normal. There were over 30 per cent. of such cases among the younger and middle-aged adults among the Cheyenne River Sioux, and about the same proportion at Fort Yates, particularly in the vicinity of the Farm School. At first the symptoms were puzzling and attributed to rheumatism, excessive use of coffee, or tobacco; but it was soon seen that in most if not all cases they were connected with a greater or lesser thyroid enlargement, and eventually it became plain that they were due to the latter and were the symptoms of thyroid derangement.

The foremost question in this connection is, what are the causes of this localized prevalence of serious disturbances of the thyroid gland. It is not a tribal peculiarity, for other branches of the Sioux away from the river are less affected. There is no evidence that the disease extends for any great distance along the Missouri, or is common among the whites of same localities. The water used by the natives is mostly that of the Missouri and its small affluents. The present habits of these Indians are those of fairly civilized Indians in general. They were always hunters and great meat eaters, and are doubtless still more so than agricultural tribes, but this is true of all the Sioux. The country is of the rolling prairie type, the climate rigorous but not over-severe. Malarial infections are infrequent, but scrofula, consumption and venereal diseases prevail; all of which affords no clue as to the causes of the goiter.

It seems that here, if anywhere, in this country there is a good chance for a thorough investigation, by modern means, of the conditions leading to thyroid enlargement. The people concerned are very tractable, and both reservations are within easy reach of the railroad. The Bureau of Indian Affairs would doubtless favor and assist the investigations. In his visits to upwards of 50 tribes the writer has never met with a locality where the thyroid "infection" was as prevalent and active, and where conditions for research into its causes

In conclusion it may be added that goiter among Indians is not, so far as the writer's experience goes, connected with cretinism, which seems not to occur at all in that race, or with myxedema, and only rarely and moderately with exopthalmy.

Aleš Hrdlička
U. S. National Museum

COMPULSORY MATHEMATICS—AN EXPLANATION

To the Editor of Science: Professor Keyser, in reviewing Professor Miller's "Historical Introduction to Mathematical Literature"[1] speaks of "the nation-wide depreciatory utterances of such educational leaders and agitators as Commissioner Snedden and Abraham Flexner" (relative to the value of the study of mathematics, I infer). I think he can not be fully informed as to my position.

My objection is merely against giving high-school mathematics a highly "protected" position, shared by no other subject except English, as we do now through college entrance requirements and the traditions controlling in secondary schools. I know (having been a moderately successful teacher of high-school mathematics myself for several years) that a substantial percentage of high-school pupils, otherwise of good ability and promise, do not respond well to mathematic teaching, and, I believe, do not materially profit from the assigned tasks, which are uninteresting, discouraging, and even, at times, obnoxious, to them. I think this is frequently the case with pupils of literary bent and artistic leanings.

I naturally very much favor the extended study (preferably under better teaching than we now obtain from the teachers prepared by our college departments of mathematics) of secondary school mathematics by all those anticipating vocational studies or pursuits where the results of such study serve a demonstrably instrumental purpose. Furthermore, I should strongly encourage other pupils to undertake these studies and to pursue them vigorously as long as they can be made to find the drill and the broadening outlook given by them interesting and, probably, fruitful.

[1] Science for July 7, 1916, pp. 25–28.

But I do not attach much weight to the pedagogical principle, succinctly stated by Dooley that "It doesn't matter what you teach a boy, so long as he doesn't like it." To give point to my attitude, I have frequently asked the question "Why should a girl be required to 'pass' in mathematics as a condition of entering an American college and (usually) of graduating from an American high school?" Is algebra, as usually taught, a subject of such unique educational excellence in general education, and does it in so exceptional a measure train the mind or give rise to the appreciations and insights which we call culture, that it should have the monopolistic position in our secondary schools which we now give it? To me this is an important question; and in asking it, I have no intention of depreciating the values, demonstrable or assumed, which that subject may still possess for a large proportion of the one million three hundred thousand pupils now found in our public high schools.

DAVID SNEDDEN

COLUMBIA UNIVERSITY,
July 18, 1916

THE SOUTHERN BULLFROG, RANA GRYLIO STEJNEGER

THE southern bullfrog was first pronounced a distinct species by Dr. Leonhard Stejneger of the U. S. National Museum in 1902.[1] Miss Dickerson in "The Frog Book" (1906) describes and gives photographs of this southern frog. It has been reported only from Pensacola, Kissimmee and Ozona, in Florida, and from Bay St. Louis, in Mississippi. It is evident that little is known concerning the limits of the range of this frog.

Although the frog was first obtained at Bay St. Louis, Mississippi, it appears to have been known to some of the older naturalists more than a century ago. It is interesting to note that William Bartram appears to have been well acquainted with this frog and considered it distinct from the common bullfrog, *Rana catesbiana*. This excellent naturalist, on page 272 of his book, "Travels through North and South Carolina, Georgia, East and West Florida" (1792), says:

> The largest frog known in Florida and on the seacoast of Carolina is about eight or nine inches in length from the nose to the extremity of the toes; they are of a dusky brown or black color on the upper side, and their belly or underside is white, spotted and clouded with dusky spots of various size and figure; their legs and thighs also are variegated with dark brown or black; and they are yellow and green about their mouth and lips. They live in wet swamps, on the shores of large rivers and lakes; their voice is loud and hideous, greatly resembling the grunting of swine; but not near as loud as the voice of the bullfrog from Virginia and Pennsylvania: neither do they arrive to half the size, the bullfrog being frequently 18 inches in length and their roaring as loud as that of a bull.

From Bartram's description of the color and markings, one can not say with certainty that he did not confuse the southern bullfrog to some extent with the common bullfrog, which is also known to extend its range into Florida. However, his description of the voice makes it certain that he had heard the frog *Rana Grylio* as named by Stejneger.

H. A. ALLARD

WASHINGTON, D. C.,
April, 1916.

[1] "A New Species of Bullfrog from Florida and the Gulf Coast," *Proc. Nat. Museum U. S.*, Vol. 24, pp. 211–215, 1902.

SCIENTIFIC BOOKS

Outlines of Industrial Chemistry. By FRANK HALL THORP, Ph.D., with assistance in revision from WARREN K. LEWIS, Ph.D., professor of chemical engineering in the Massachusetts Institute of Technology. Third revised and enlarged edition. Published by the Macmillan Co., New York. Cloth. 8vo. Pp. 665. Price $3.75.

As the second edition of this well-known text-book appeared in 1905, a material revision of its pages was found necessary and many sections have in consequence been altogether rewritten with elimination of obsolete matter and introduction of new material.

One of the problems which must necessarily present itself to the writer of a one-volume text-book on so extensive a subject as industrial chemistry is to know how to choose the

fundamental facts needed to enable the student to get a properly proportioned picture of an important individual industry. Too much detail can not be indulged in or the book soon becomes encyclopedic and the relationship and interdependence of related industries is lost sight of. German text-books on chemical technology, like Wagner's well-known work, become ultimately too bulky to be available as text-books, and of quite a number published in that language there is at present only one that may be called sufficiently inclusive and yet remains compacted into one volume of modern size, viz., Ost's "Chemische Technologie," which has in consequence run quite rapidly through many editions.

Professor Thorp planned at first to omit metallurgy because it was generally treated separately in special text-books, but he has reconsidered this, and Part III. of the present edition is devoted to metallurgy. He has sought to economize space by leaving the chemistry of coal-tar colors out of special consideration, although a classification of them according to the conditions of their application in dyeing processes has been found necessary. With the awakening interest in the establishment of an American dye-color industry, it will probably be found desirable to take up the chemistry of coal-tar intermediates and ultimate color products for all advanced chemical students. When congressmen and the daily newspapers begin to discuss the merits of our new dye-color tariff, the graduates of our technical schools must be ready to talk intelligently on the subject.

The new edition of Professor Thorp's book covers, however, a great range of important subjects and covers them well, presenting the outlines of processes clearly and making the subject interesting to the reader or student.

As an illustration we would note the article on Glass Manufacture on pp. 196 et seq. The presentation shows the clearness of view acquired by the teacher who has learned clarity of expression by the experience of the classroom. The same may be said of the section on Pigments, p. 222, which is excellent in form and substance. If we may be allowed to criticize the treatment of some of the sections, we would say that the asphalt section is hardly adequate in its handling of either the chemistry or the technology of this important subject, and the present view of asphalt as polymerized petroleums rather than oxidation products is not mentioned.

Similarly under the Match Industry we find no mention of the use of P_4S_3, phosphorus sesquisulphide, in the manufacture of the "strike-anywhere" matches which have come in with the legislation against the use of white phosphorus for match compositions.

The modern theories with regard to colloids are noted and in several sections, the phraseology of modern colloid chemistry has been applied to explain fundamental phenomena. We can not be sure that the understanding of these processes has always been improved by this unreserved application of colloid theories, as, for example in the explanation of leather manufacture on p. 573.

The book, however, as before said, is generally up to date and clearly written, with a uniformity of method of presentation which makes it much better for a text-book than works made up of contributed articles of varying degrees of value from a number of writers.

S. P. Sadtler

Urgeschichte der bildenden Kunst in Europa von den Anfängen bis um 500 vor Chr. Von M. Hoernes. Zweite durchaus umgearbeitete und neu illustrierte Auflage mit 1330 Abbildungen im Text. Mit Unterstützung der Kais. Akademie der Wissenschaften in Wien. Wien 1915. Kunstverlag Anton Schroll & Co., Ges. M. B. H. Pp. xiv + 661.

The period elapsing since 1898, when the first edition of this important work appeared, has been one of marked progress in our knowledge of prehistoric art. The author, being able to take full advantage of the opportunity, has made of the new edition practically a new work.

The first part deals with primitive art in general. Geometric art is found to be neither older or younger than realistic art. One can say however that it is the more common, the

easier; in fact among some races it is the only art, and hence among such presumably the older. In other cases it plays a secondary rôle. In Europe at least it appeared only after a long and brilliant period of naturalism. The realistic art of the Cave period may be looked upon as the art of the male, and that of the neolithic period as that of the female; in other words sex is supposed to be at the basis of the differences between realism and conventionalism. The making of basketry and pottery was the work of woman, and their ornamentation, the product of her mind. In this cleavage religion, or the absence of it, might also have had something to do; for the tendency of religious art is toward the conventional, while that of profane art is toward the natural. Thus in the opinion of the author idols were unknown until the neolithic age.

Our conception of prehistoric art is of necessity based on partial evidence only. We can know nothing of the then existing dance, music and poesy; and very little of art as expressed in personal adornment.

It is justly pointed out that the differentiation between the historic and the prehistoric does not consist in a knowledge of any particular one of the three principal metals of antiquity; for in the Orient the historic period long antedates the closing of the bronze age, whereas the historic period in Europe begins during the iron age. Differences equally marked are to be noted elsewhere. The negroes of Africa, for example, with their knowledge of iron, have not yet reached so high a stage of culture as did the prehistoric peoples of Central and South America, among whom the use of iron was absolutely unknown.

The three great culture stages in Europe—the paleolithic, the neolithic, and the age of metals—correspond to three great phases of art: *Jägertum, Bauerntum,* and *Herren-* or *Kriegertum.* The art of the hunter stage lasted longest and reached its highest development in western Europe, especially southern France and northern Spain; that of the peasant stage took deepest root in central and northern Europe; while the martial stage first came to fruition in southern Europe. The art of the first stage was naturalistic, of the second geometric, and of the third a return to a higher realism under the control of conventionalism.

The author takes issue with Breuil respecting the age of the wall paintings of southern and southeastern Spain. From the viewpoint of art these certainly differ from the paleolithic mural art of the Cantabrian region. It is probable therefore that they belong to a later epoch, even later than the Azilian, although many of the designs on the painted pebbles of Mas d'Azil have their counterparts in the mural art of southern Spain as recently noted by Obermaier.

For Hoernes the Cave art of southern France and northern Spain is a highly specialized type, a peripheral culture phenomenon. Hence from it the art of the succeeding epochs did not and could not spring, because of a well-known law in evolution that highly specialized types of one geologic horizon do not give rise to the types of subsequent epochs.

In the field of ceramic art Hoernes distinguishes two fundamental methods of ornamental treatment: the *Umlaufstil* and the *Rahmenstil.* The first with its space-filling banded ornament is supposed to be the older, although neither is wholly confined to the neolithic period. The second with its panel ornamentation goes logically with the various forms of handled ware. The banded style, on the other hand, is expressive of ware without handles; to it belong the spiral and meander decoration.

During the bronze age the best examples of decorative art are to be seen in metal work; this is especially true of northern Europe. It was during this age that plant motives first appeared.

The passage from the bronze age to the iron age took place slowly, at first in the Orient and in Egypt; in Greece about 1200, in Italy 1100, and in central Europe about B.C. 1000. In the ceramic field the Hallstatt epoch is not so much an outgrowth from the bronze age as from the neolithic age. The banded as well as the panel style of the Hallstatt epoch is foreshadowed in the neolithic pottery of

east central Europe. The Dipylon and the Villanova style representing the earliest phase of the iron age in Greece and Italy, respectively, both abound in banded and panel patterns, especially the meander and the swastika. (The swastika is supposed to date as far back as the neolithic period.)

The art of the smith made rapid strides during the Hallstatt epoch. A process was developed of at least superficially hardening a blade of iron, although steel proper was as yet unknown. The engraved ornaments of the bronze age now give place largely to embossed patterns produced by hammering. With the epoch of La Tène the art of the third and last great stage (Kriegertum) spread over western and northern Europe.

The revision is everywhere both conservative and thorough; some thirty pages of addenda and references will contribute much toward its usefulness as a source book.

George Grant MacCurdy
Yale University,
New Haven, Conn.

THE MECHANISM OF LIGHT PRODUCTION IN ANIMALS

It has long been known that the dried powdered luminous organs of the fire-fly will glow if moistened with water containing oxygen. No light is given off if oxygen is absent. In a previous issue of Science I pointed out that if we allow this dried powder to stand for an hour in contact with water carefully freed of its dissolved oxygen and then admit oxygen, no phosphorescence is to be observed. It is quite obvious that the photogenic substance has been changed in some way even though no oxidation has taken place. The substance, therefore, which in presence of oxygen is oxidized with the production of light, in absence of oxygen is also decomposed but without light production. We have an analogous instance in the compound lophin (triphenylglyoxaline) investigated by Radziszewski. If hydrolyzed in presence of oxygen by alcoholic potassium hydrate, light is produced and benzoic acid and ammonia formed. In absence of oxygen, no light is produced and benzaldehyde is formed instead of benzoic acid. The alkali acts as a catalyzer.

In the fire-fly it is natural to suppose that an organic catalyzer, an enzyme, is concerned in light production and it is the purpose of this paper to point out the fact that the existence of such an enzyme has been definitely proved and to add certain new facts to our knowledge of bioluminescence. The credit of this discovery belongs entirely to Professor Raphael Dubois, of the University of Lyons. As early as 1884 Dubois made the crucial experiments in which he showed that two substances are present in the luminous organs of *Pyrophorus noctilucus,* the West Indian cucullo, a thermostabile substance, luciferin, which oxidizes with light production and a thermolabile enzyme luciferase. In 1887 Dubois showed that the same was true for the luminous mollusc, *Pholas dactylus.* If the luminous slime from glands on the siphon and mantle of this mollusc are collected in sea water in two test tubes the solutions will phosphoresce for some time. Boil the solution in one tube and the light disappears instantly; allow the solution in the other tube to stand until the light disappears spontaneously. Then if both tubes, now dark, be mixed, the light reappears. The boiled tube contained luciferin but no luciferase while the other tube contained luciferase but all the luciferin had been oxidized by standing. On mixing, the two substances were again brought into contact and light resulted. In later papers Dubois has studied especially the properties of the *Pholas* luciferin and luciferase and the results are published in many papers in the *C. R. Acad. Sc. Paris* and the *C. R. Soc. Biol.* He says that luciferin is an albumin having acid properties and an active reducing power. It oxidizes readily with luciferase, potassium permanganate, barium peroxide and lead peroxide, giving off light and forming amino-acids and minute crystals giving the test for xanthin.

Luciferase, on the other hand, has all the properties of an enzyme, an oxidizing enzyme acting in the presence of iron salts, which will oxidize luciferin and also tannin, guaiac, a-

napthol, etc. It resembles the oxydones of Batelli and Stern which are destroyed by ether, chloroform and acetone. It passes with difficulty through porcelain and is non-dialyzing. At 60° C. it is destroyed by heat, as also by digestion with trypsin.

It is astonishing that work such as that referred to above, published in well-known journals by a competent physiologist, should have received so little attention. No good account of Dubois's work is to be found in any of the physiologies in English or German, although he is mentioned as the author of the luciferin-luciferase "theory." I have recently been able to confirm a great many of Dubois's statements and to add some new facts. My material has been the West Indian cucullo, *Pyrophorus*,[1] the eastern American fire-flies, *Photinus* and *Photuris*, and luminous bacteria. There is absolutely no doubt of the existence of luciferase and luciferin and the possibility of separating these two substances.

I find that luminous bacteria also contain luciferin in very small amount and this can be precipitated by treating the bacteria with absolute alcohol and drying quickly. Such a dry powder gives no light with water, but a faint light with the luciferase of the fire-fly. I have been unable to obtain luciferase from the bacteria, due probably to the fact that, like so many of the bacterial enzymes, it is present as an endoenzyme and can only be extracted by high pressures. Curiously enough the bacterial luciferin can not be obtained by destroying the luciferase through heat. Lack of space does not permit of a discussion of this here, but the full details will be published later.

Luciferase of one form will act with luciferin of another, and *vice versa*. This is true for the two genera of eastern fire-flies (*Photinus* and *Photuris*) and for the West Indian *Pyrophorus* (*Elsteridæ*) and *Photuris* or *Photinus* (*Lampyridæ*). Fire-fly luciferin will give no light with extracts of non-luminous parts of the fire-fly or with non-luminous insects or extracts of pill bugs, earthworms or slugs.

Whether the luceferin and luciferase of all forms are identical is still an open question. We know of many organic substances such as oils, alcohols, lophin, etc., which will phosphoresce at relatively low temperatures with alkalies, so that it would be by no means remarkable to find that the luciferin of different forms was different. I have this past winter discovered a luminous reaction which is remarkable in many ways and which closely parallels the method of light production in luminous forms. Pyrogallol will produce light with the vegetable oxidases (potato or turnip juice) if we add some hydrogen peroxide. As little as one part of pyrogallol in 254,000 parts water ($m/32{,}000$) will give perceptible light and $m/8{,}000$ a good light. Faint light is produced at 0° C. and a good light at 10° C. A characteristic of luminous animals is that they still produce light at 0° C. The pyrogallol + H_2O_2 corresponds to luciferin and the vegetable oxidase to luciferase. Like the luciferase of luminous forms the oxidase is destroyed by boiling. We might therefore separate a luminous mixture of pyrogallol + H_2O_2 and potato juice into a thermostabile and thermolabile component which would again give light if brought together. Mammalian blood may take the place of the oxidase of plant juices.

In a general way, then, we may say that the problem of bioluminescence has been solved at least in its broad aspects. There still remain many details to be filled in, details which will take some time to complete. The exact chemical nature of luciferin is unknown, but the method of attack of the problem has been outlined and all that is necessary is a sufficient quantity of the luminescent material for the determination of its chemical nature. That it may be difficult to obtain enough for analysis is indicated by the luminescence of pyrogallol which takes place in the almost inconceivably small concentration of 1: 254,000.

E. NEWTON HARVEY

TOKIO, JAPAN,
May 1, 1916

[1] My studies of *Pyrophorus* were made under the auspices of the department of marine biology of the Carnegie Institution of Washington.

SPECIAL ARTICLES

ON THE ASSOCIATION AND POSSIBLE IDENTITY OF ROOT-FORMING AND GEOTROPIC SUBSTANCES OR HORMONES IN BRYOPHYLLUM CALYCINUM

Recent experiments have led me to results which suggest that the substances responsible for root-formation in the stem of *Bryophyllum calycinum* are associated or possibly identical with the substances responsible for geotropic curvatures of the stem of this plant.

1*a*. When we cut out a piece of the stem of *Bryophyllum* and suspend it horizontally in a vessel saturated with water vapor, the stem will bend to such an extent that it assumes the shape of a U, the concave side being on the upper side. It was found that this geotropic curvature is due to a growth (or some other form of active stretching) of the cortex in the convex region of the lower half of the stem. The upper half of the stem is bent passively through the growth of the lower half. This was ascertained by measurements on marked stems split longitudinally, and suspended horizontally.

1*b*. It was found that root-formation appears generally in that node around which the curvature takes place and that it is confined in the bending region to the nodes on the lower side of a horizontally suspended stem. It is thus seen that the geotropic growth (or active stretching) and the root-formation both take place on the lower side and in the same region of the stem.

2*a*. When we cut out a piece of stem from *Bryophyllum* containing from four to seven nodes (but with the two most apical nodes cut off) and if we remove all the leaves such a stem will form roots at the two most basal nodes (and sometimes also at the basal surface) and new shoots at the two most apical nodes, but this new growth is extremely slow. If, however, a leaf is left on the stem the new organs will grow out much more rapidly.

2*b*. When such a stem without leaves is suspended horizontally it will bend geotropically, but the bending will take place very slowly. If, however, a leaf is left on the stem the geotropic curvature takes place with much greater rapidity.

3*a*. When we remove all but one apical leaf on the lower side of such a horizontally suspended stem, the stem will form roots first in the second node from the leaf; but only from the node on the under side of the stem. Roots will also grow out from the two most basal nodes.

3*b*. In the same stem the geotropic curvature will occur in the region where the first growth of roots takes place; namely around the second node behind the leaf.

4*a*. When all the leaves are removed with the exception of one leaf in the basal node (on the under side of the horizontally suspended stem), root-formation will be scant and will only take place at the cut surface at the basal end of the stem behind the leaf; and sometimes also from the axilla of the leaf.

4*b*. In such a stem the geotropic curvature is generally considerably less than when an apical leaf is left and is confined to the piece of internode behind the leaf and to the immediate neighborhood in front of the leaf.

5. In all these experiments the region of curvature (and of growth of the cortex) coincides with the region where the most rapid growth of the roots takes place (or where root-forming substances or hormones collect).

6. The effect of the position of a single leaf on the stem is much more striking when we remove the upper half of the cortex in a horizontally suspended stem of *Bryophyllum*. Such stems become at once very strongly convex on the upper side, due to the release of the passively contracted wood and pith on the upper side, where the cortex is removed. When in such a stem all the leaves are removed except the one on the lower side at the apical end of the stem, the latter will gradually overcome the convexity on the upper side and assume the geotropic U shape with the concavity on the upper side due to geotropic growth of the cortex on the lower side of the stem, in the region around the second node behind the leaf. If, however, the leaf is left at the basal end no geotropic curvature will occur (at least none appeared as long as the stems were observed). If the cortex is removed on the lower side no geotropic curvature is possible since this curva-

ture is due to the growth of the cortex on the lower side of the stem.

7. It is known that the geotropic "stimulus" can travel around a corner, *i. e.*, around an incision through half the thickness of the stem, which is to be expected if the "stimulus" consists in the flow of a liquid. If such incisions are made alternately across the upper and lower half of each internode of a horizontally suspended stem with only one leaf on the under side, the stem will show geotropic curvature if the leaf is in the apical node; but will show as a rule no curvature if the leaf is in the basal node; or a slight curvature in the neighborhood of the basal node may occur after considerable delay.

8. All these experiments agree with the assumption that each leaf sends a current of root-forming substances towards the base of the stem, and a current of shoot-forming substances towards the apical end of the stem; that the root-forming substances have a tendency to collect at the lower side of a horizontally suspended stem, and that they are associated or identical with the substances causing the growth of the cortex on the lower side of the stem to which the geotropic curvature is due.

9. This idea is further supported by experiments with stems split into two longitudinally. If such split stems are suspended horizontally only those halves show geotropic curvatures whose cortex is below. If the cortex is above (and the cut surface of the stem below) almost no geotropic curvature takes place, no matter where the leaf is, for the simple reason that such stems are lacking the cortex on the lower surface. If the cortex is below and one leaf left at the apical end, root-formation will take place just as rapidly as in the intact stem and geotropic curvature still more rapidly (since the passive resistance of the upper half is removed). If, however, the leaf is left at the basal end, in about 50 per cent. of the cases no geotropic curvature takes place, or if it takes place it is confined to the region of the basal node; and is considerably less than if the leaf is left at the apical end.

If the pieces have no leaf they will bend more strongly than when a leaf is left at the basal end only, thus indicating a possible inhibiting influence of the basal leaf upon the curvature in the more apical regions of the split stem.

10. All these facts suggest a close association if not identity between the root-forming substances and the substances (or hormones?) causing geotropic curvatures. Such a close association or identity between organ-forming and geotropic substances might also explain why it is that in some cases geotropism can restore the form in the same way as does regeneration, as, *e. g.*, in certain fir trees, where one of the upmost horizontal branches will begin to grow vertically when the apex is cut off.

JACQUES LOEB
THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH,
NEW YORK

THE AMERICAN CHEMICAL SOCIETY

THE 52d meeting of the American Chemical Society was held at the University of Illinois, Urbana-Champaign, April 17 to 21, 1916. The meeting was an unusually enthusiastic one, the total registration being the largest to date, namely, 728. A detailed description of the social and other events of the meeting will be found on page 396 of the *Journal of Industrial and Engineering Chemistry* for May, 1916. The general meeting and meetings of the Divisions of the Society were held in the lecture rooms of the chemistry building of the University of Illinois. Some notable features were presented in the "Special Program for Home Economics" by the Division of Biological Chemistry; in the "Symposium on the Activated Sludge Method of Sewage Purification," by the Division of Water, Sewage and Sanitation, and in the "Symposium on the Chemist in Food Control," by the Division of Agricultural and Food Chemistry.

The following general addresses were given:

The Composition of Corn as affected by Nineteen Generations of Seed Selection: L. H. SMITH. (Lantern.)

The Manufacture of Chemical Apparatus in the United States: ARTHUR H. THOMAS.

The War and the American Chemical Industry: RAYMOND F. BACON.

On the Influence exerted by Electrolytes on the Equilibrium of Emulsions, Jellies and Living Cells: G. H. A. CLOWES. (With demonstration.) (Lantern.)

Some Effect of High Pressures: John Johnston. (Lantern.)

Public Lectures. Complimentary to the citizens of Champaign and Urbana.

Charles L. Parsons, "Production of Radium," illustrated by lantern slides and moving pictures.

Curtis F. Burnam, "Use of Radium in Treatment of Cancer," illustrated.

All divisions of the society held well-attended meetings. The titles of papers presented follow with abstract so far as abstracts could be obtained.

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

L. M. Tolman, *Chairman*

Glen F. Mason, *Secretary*

Cattle Foods: Carl S. Miner.

Starch and Glucose: A. P. Bryant.

The Chemist in the Canned-food Industry: W. D. Bigelow.

The canner, like other manufacturers, sometimes finds it advantageous to have miscellaneous supplies examined. The laboratory finds a greater field of usefulness, however, in determining the cause of and finding a means of preventing various kinds of spoilage and real and apparent inferiority. This sometimes involves the systematic study of methods of canning in order that the exact technique that will uniformly give the best results may be accurately defined. All this work requires an intimate knowledge of the technology of the industry. Laboratories frequently make serious errors in answering questions submitted by canners, because of an imperfect knowledge of the facts. Errors of this sort do great damage to the industry and work injury to the reputation of the chemical profession. Greater care on the part of chemists is urged in such matters.

The Chemical Control of Gelatin Manufacture: J. R. Powell.

Chemical control has been limited until quite recently, but when demanded by the advance in food requirements, its installation has proved of value to the manufacturer. This control covers the inspection of raw material and chemicals; the control of the actual manufacturing process, and the inspection of the finished product and by-products. Raw material is examined for its yields and the presence of interfering impurities. Manufacturing processes require such attention as will prevent the introduction of impurities, and the deterioration of the gelatin. The finished product is examined to judge its commercial value, and suitability for food purposes.

Flour: Harry Snyder.

The Removal of Barium Chlorid from Table Salt: W. W. Skinner.

A preliminary investigation by the Bureau of Chemistry showed that salts of certain grades contain considerable amounts of barium chlorid. As barium chlorid is a poisonous substance the use of such salt in food products is a menace to health. Therefore, the elimination from the market of salt containing barium chlorid in any appreciable quantity is highly desirable.

A method of treatment has been developed for the removal of the barium from the brine. This method depends upon the addition of sodium sulphate and calcium oxide in proper proportions and the blowing of air through the treated brine to decompose the ferrous bicarbonate, naturally present, thus obtaining a rapid precipitation. The method gave such promising results in the laboratory and from a test run of six days in the works, that one large salt manufacturer decided to try it out and installed the necessary equipment for the treatment of 200,000 gallons of brine per day. The treatment was begun in September, 1915, and has been in operation continuously ever since. The results so far obtained indicate that the process is a complete success. Ordinarily two and sometimes three grades of salt are produced. Since the installation of the process, however, the entire output of the plant has been of the No. 1 grade known to the trade as table and dairy salt. No off grade or No. 2 salt is produced. The cost of treatment is estimated at from 1¼ to 1½ cents per barrel. About sixty thousand barrels of salt containing only insignificant traces of barium have been produced by the new process.

Flavoring Extracts: George Lloyd.

The High Character of the Manufactured Foods offered the Public To-day: A. V. H. Mory.

Experience gained from careful examination of several hundred samples of manufactured food products, representing nearly all varieties, shows that adulteration and misbranding are seldom met with to-day in the goods of reputable producers, and that the adulteration that represents a serious menace to health is practically non-existent.

About the only service the laboratory of a large distributing house has been able to render is that of helping the expert buyers to select the best from a number of perfectly legal and wholesome products submitted for consideration; all of which is a testimonial to the present efficiency of law enforce-

ment made increasingly efficient by cooperation on the part of the reputable producer and distributer, who finds in the enforcement of these laws the elimination of unfair competition.

Preventing the Staling of Bread by Cooling in a Predetermined Atmosphere: ARNOLD WAHL.

Bread and like products absorb while cooling a considerable volume of gas from the atmosphere in which it rests, due to a vacuum caused by the physical condensation of the carbon dioxide in the pores of the loaf and by the solution of carbon dioxide in the free water of the bread, the solubility increasing as the product cools. Bread cooled in an atmosphere of oxygen becomes stale in a few hours while bread cooled in an atmosphere of carbon dioxide is so modified as to remain fresh for several weeks, the reason being that in the former case oxidation of the protein occurs similarly to the effect of oxygen on the nitrogenous constituents of beer, while in the latter oxidation is prevented. I prefer to employ carbon dioxide freshly produced by fermentation for this purpose, having been determined by long experience in brewing to be best suited to combine chemically with nitrogenous food substances.

Use of Picric Acid in Meat Sugar Solutions: W. B. SMITH.

Proteoses, peptones and the greater portion of the amino-acids are removed from meat extracts by excess of picric acid combined with excess of phosphotungstic acid in aqueous solution. More amino-phosphotungstates are removed by adding hydrochloric acid to the filtrate.

Little free hydrochloric acid remains, permitting estimation of reducing sugar if quickly done. Bertrand's copper solutions and Low's iodid method are used. Total sugar is determined after inversion.

Mercuric acetate, followed by phosphotungstic and hydrochloric acids, gives the same results, but removal of excess mercury is essential. Picric acid does not interfere with reduction of Fehling's solution.

The Analysis of Maple Products VIII. The Application of the Conductivity and Volumetric Lead Subacetate Tests to Maple Sugar: J. F. SNELL AND G. J. VAN ZOEREN.

A representative sample of the sugar, say 100 grams, is dissolved in hot water, boiled to 219° F. (103.9° C.) and filtered through cotton wool. The resulting syrup is tested as directed in Papers VI. and VII. Pure products give conductivity values and volumetric lead values within the limits reported for genuine syrups in Papers VI. and VII.

Chinese Preserved Eggs—Pidan: KATHARINE BLUNT AND CHI CHE WANG.

Pidan is a kind of Chinese edible preserved eggs made by covering fresh ducks' eggs by a pasty mass of lime, wood ashes, salt and tea, and finally rice hulls. It is solid, the yolk and white still separate and very dark colored, and with remarkably ammoniacal odor. The moisture of pidan yolk is higher than that of fresh ducks' eggs, and of the white very much lower, hence water has been transferred from the white to the yolk and lost to the air. The ether extract of the yolk is low (only 21 per cent.) and its acidity high (8 per cent.). The ash is high and alkaline. Coagulable protein is lower than fresh hens' eggs, and, the most marked change, ammoniacal nitrogen by Folin's method is extraordinarily high (0.06 per cent. determined on the filtrate from the coagulable nitrogen).

A Study of American Beers to show the Effects on Their Composition of Various Raw Materials used in Their Production: L. M. TOLMAN AND J. G. RILEY.

DIVISION OF AGRICULTURAL CHEMISTRY

The Effects of Plant Foods upon the Amount and Quality of Substances used for Foods, particularly Fruit and Vegetables: H. A. HUSTON.

Does the Oxidation of Tetrathionate to Sulfur affect the Accuracy of the Estimation of Thiosulfate by Means of Iodine? PHILIP L. BLUMENTHAL AND S. D. AVERITT.

In neutral or barely acid solutions, an excess of iodine oxidizes tetrathionates to sulfates. Experiments showed an oxidation of 18 per cent. of the total sulfur in two weeks, with the excess of iodine as 2: 1. Whenever thiosulfate is titrated with iodine, a small amount of sulfate is formed. This does not cause an appreciable error when N/10 solutions are used. In the analysis of lime-sulfur solutions by iodine titration, the volumetric results on thiosulfate agree very closely with the value obtained by oxidizing the tetrathionate with bromine weighing as $BaSO_4$. The sulfate formation noted might be due to presence of a little sulfite, but there is reason to believe none is present.

Separation and Estimation of Polysulfides and Thiosulfate in Lime Sulfur Solutions: S. D. AVERITT.

The quantitative separation of polysulfides preparatory to the determination of thiosulfate is accomplished by means of standard solutions of iodine or hydrochloric acid using appropriate indicators.

The precipitated sulfur from either titration may be weighed directly. A quick accurate method of weighing it is described.

It is shown that H_2S may be removed from a slightly acid solution by boiling without decomposing thiosulfate, also that tetrathionate is converted into thiosulfate by an excess of soluble sulfid, the latter decomposed with HCl, the H_2S removed by boiling and the thiosulfate titrated.

Sodium nitroprusside may be used as internal indicator.

Some Studies on Liquid Fertilizer: G. D. Beal and D. T. Englis.

The Detection of Lime used as a Neutralizer in Dairy Products: H. J. Wichman.

Division of Biological Chemistry

C. L. Alsberg, *Chairman*

I. K. Phelps, *Secretary*

The following papers were read by title:

Mutarotation of Gelatine and its Significance in Gelatin: C. R. Smith.

Chemical Studies on the Decomposition of Red Oak by Fomes applanatus and of Red Spruce by Trametes pini var. abietis: E. J. Piper, C. J. Humphrey and S. F. Acree.

Some Observations on the Bacterial Metabolism of Sulfur Compounds: F. W. Tanner.

A Study of the Ethereal Sulphates of the Urine in Certain Chronic Diseases: J. Rosenbloom.

The Ammonia Content of Human Gastric Juice: J. Rosenbloom and Jena Miltan.

Some Auxoamylases: E. W. Rockwood.

The Non-Protein Constituents of Foods and Feeding Stuffs: H. S. Grindley and H. C. Eckstein.

Swine Feeding Experiments to determine the Nutritive Value of the Amino Acids: J. C. Ross.

Further Observations on the Surface Tension of Saponin Solutions: C. L. Alsberg and H. E. Woodward.

The Changes in the Amino-acid Nitrogen and Soluble Non-protein Nitrogen: R. S. Potter and R. S. Snyder.

Diet in its relation to the Treatment of Diabetes: E. E. Butterfield.

The Nitrogen Distribution in Certain Seeds: C. L. Alsberg and F. Brewster.

Phospholipins, Lecithin, Cephalin and Similar Substances: M. Louise Foster.

The Fate of Methylene Disalicylic Acid and Derivatives in the Body: R. A. Hall and E. D. Brown.

The Pharmacological Action of Citrates: R. A. Hall and R. E. Morris.

On the Esterfication of Amino Acids: H. H. Shonle and H. H. Mitchell.

Digest of Data on Mineral Substances in Diet: Grace MacLeod.

The Temperature of Potatoes while Cooking and a Method of Measuring Temperature during Cooking and Canning: R. D. Milner.

The Organic Phosphorus of Soil: R. S. Potter and T. H. Benton.

The Chemical Aspect of Photosynthesis in Plants: H. A. Spoehr.

The Growth of Isolated Plant Embryos: G. D. Buckner and J. H. Kastle.

A Chemical and Bacteriological Study of some Non-Pathological Gastric Residuums: C. C. Fowler, M. Leviné and S. B. More.

A Study of Eighty Samples of Gastric Residuums Obtained from Apparently Normal Women: C. C. Fowler and Z. Zentmire.

Relative Sensitivity of Some Commercial Litmus Papers: Arno Viehoever and Clare O. Ewing.

Blue, neutral, red litmus papers from nine American manufacturers and one foreign manufacturer were found to vary in sensitivity within very wide limits. Best results were obtained when the "blue" papers were of a dull or grayish blue color; the "neutral," a dull lavender or pinkish-violet; and the "red," a light pinkish red. It is considered that good papers should respond quickly to $N/500$ acid or alkaline solutions.

By means of a "spot test," in which one or more drops of the solution to be tested were superimposed on the test paper, thus in effect concentrating the solution, the reaction of solutions as dilute as $N/25{,}000$ (1: 500,000) H_2SO_4 and $N/2{,}000$ (1: 50,000) NaOH could be determined.

On the Determination of the Digestibility of the Constituents of a Mixed Diet: H. H. Mitchell and H. S. Grindley.

A method of determining the digestibility of the constituents of a mixed diet is proposed, based on the product-moment method of correlation. The daily intake of nitrogen from each food ingested is correlated with the daily excretion of nitrogen in the feces. Coefficients or regression of fecal nitrogen on each type of food nitrogen are then calculated, giving figures representing the average increase of fecal nitrogen for an increase in intake of 1 gram in meat nitrogen, bread nitrogen, etc. From these coefficients, the digestibility of the nitrogen of each of the foods ingested may be calculated. The digestibility of the fat, phosphorus, chlorine, etc., of the individual foods may be calculated in a similar fashion.

Feeding Experiments on the Nutritive Value of Casein: E. M. K. GEILING AND H. H. MITCHELL.

Casein boiled for 2 hours is still able to maintain adult mice for at least 50 days. Casein moistened and heated in an autoclave for 1 hour at 15 lbs. does not appear to lose its value for maintenance of adult mice. Four mice were maintained for 70 days and 2 for 84 days on a ration containing this product. Casein was digested with pancreatin and then treated with 9.5 volumes 95 per cent. alcohol. The filtrate, evaporated to dryness, was unable to maintain mice for longer than 30 to 40 days. Mice fed this product plus cystine returned to normal weight and condition. Substitution of cystine by flowers of sulfur had no beneficial effect.

The Hydrogen Electrode Potentials of Phthalate, Phosphate and Borate Buffer Mixtures: WM. MANSFIELD CLARK AND HERBERT A. LUBS.

The hydrogen electrode potentials of *M*/20 solutions of the following mixtures were measured at 20°.

Acid potassium or the phthalate—Hydrochloric Acid.
Acid potassium or the phthalate—Sodium Hydroxid.
Acid potassium phosphate—Sodium Hydroxid.
Boric acid and Kbl—Sodium Hydroxid.

The solids crystallize beautifully and are all free from water of crystallization. The acid potassium phthalate, as shown by Dodge, is an excellent substance for the standardization of the sodium hydroxid solution. The sodium hydroxid may be prepared sufficiently carbonate-free by a method outlined and the hydrochloric acid may be purified by distillation and is easily standardized. These mixtures then form a convenient system of buffer solutions to be used as standards in the colorimeter method of determining hydrogen ion concentrations.

Solutions of acid potassium phthalate alone have a strong buffer effect. This combined with the ease with which the substance can be prepared makes it an excellent standard for hydrogen electrode measurements.

A Colorimetric Method of Estimating Amylolytic Activity: VICTOR C. MYERS.

To 10 c.c. of 1 per cent. soluble starch solution add 9 c.c. of water and 1 c.c. of a solution containing the amylolytic enzyme (ptyalin, amylopsin, etc.). Digest at 38° C. At the end of some definite time, such as 30 min. (or appropriate intervals), 1 c.c. of the solution is removed, at once treated with 3 c.c. of saturated picric acid solution and 1 c.c. of saturated sodium carbonate and then heated in a beaker of boiling water for 15 minutes. After cooling, the solution is diluted to proper volume for comparison with a standard picramic acid solution in a colorimeter. From this the sugar formation (maltose), and, therefore, the amylolytic activity may readily be calculated.

The Colorimetric Determination of Glucose, Sucrose, Dextrin and Starch in Foodstuffs: V. C. MYERS AND A. R. ROSE.

A portion of a saturated picric acid extract of a 2–5 g. sample (*e. g.*, banana) is diluted with picric acid solution, so as to contain about 0.02 per cent. of soluble carbohydrates. Portions of 3 c.c. are heated with 1 c.c. of saturated sodium carbonate at 100° C. for 15 minutes and the color which develops matched against a standard solution of picramic acid. From the readings obtained and dilutions used, the reducing sugars (glucose, frutose) are readily calculated. Another 3 c.c. portion is heated for 5 minutes at 100° C. before the carbonate is added and then continued as above. This portion gives the sum of the glucose (and frutose) plus the inverted sucrose. Dextrin and starch are similarly determined after hydrolysis.

On the Citric Acid Production of Aspergillus Niger: JAMES N. CURRIE.

In a previous paper the author reported that many cultures of black aspergillus produced citric acid. For the purpose of this discussion the acid fermentation of this group of fungi may be considered as an oxidation process proceeding in three phases which may be represented by the following scheme:

Carbohydrate → citric acid → oxalic acid → carbon dioxide.

Under optimum conditions of growth the chief end product is carbon dioxide and only small amounts of citric and oxalic acids accumulate. Under restricted conditions of growth which may be obtained on synthetic media large amounts of free acids accumulate. Any one of fifteen cultures studied can be made to produce both oxalic and citric acids in various proportions, depending upon the conditions of culture and the particular strain of *A. niger* employed.

The chief object has been to ascertain under what conditions the largest yield of citric acid could be obtained. The largest yields were obtained on media to which calcium carbonate was added. This may be due to the effect of maintaining neutrality or at least a low hydrogen ion concentration in the media. Highest yields of calcium citrate were obtained on the following media:

Water	1,000	gm.
Saccharose	50	"
Sodium nitrate	2.0	"
Potassium dihydrogen phosphate	1.0	"
Magnesium sulphate	.25	"
Potassium chloride	.25	"
Ferrous sulphate	.01	"
Calcium carbonate	40	"

The form in which nitrogen is supplied and also the amount of nitrogen are the most important factors when growth is conducted in the absence of calcium carbonate. Cultures which produce no citric acid when grown in the above media with 3.0 grams of sodium nitrate per liter will produce very considerable amounts of citric acid if the sodium nitrate be reduced to 1.2 grams per liter.

The most favorable media found for the production of free citric acid was

Water	1,000	gm.
Saccharose	50	"
Ammonium dihydrogen phosphate	2.0	"
Magnesium sulphate	.25	"
Potassium chloride	.25	"
Ferrous sulphate	.01	"

On this media several strains of *A. niger* will produce almost pure citric acid with only traces of oxalic.

Growth was conducted on 50 c.c. of media contained in a 200 c.c. Erlenmeyer flask at 30° C. Cultures were examined at 6 to 10 days of age. The cultures employed were obtained from Dr. Charles Thom.

The influence of hydrogen ion concentration, the substitution of other sugars for saccharose and the influence of numerous inorganic salts on this reaction have been studied but can not be reported in detail at this time.

The Equation of Fermentation of Glucose by Bacillus coli communis: Oliver Kamm.

The acid, alcohol, gas fermentation of glucose by *B. coli*, as given by Harden,[2] was found to be a combination of several fermentations. In particular, the lactic acid fermentation was found to proceed independently. In the absence of most inorganic salts and especially of phosphates, evidence was obtained that the gas formation (carbon dioxide and hydrogen) is due to the secondary fermentations of formic acid.

The Liberation of Ammonia from Ammonium Salts by B. Coli Communis: Robert Bengis and A. R. Rose.

A synthetic medium containing ammonia lactate and ammonia phosphate was used in growing *B. Coli communis* in quantity. The bouillon, when aerated, lost appreciable amounts of NH_3 and the amount that could be removed in this way was increased by inoculation with *B. Coli communis*. In agar media the amount of ammonia given off under sterile conditions was very minute, but upon inoculation with *B. Coli* more NH_3 was liberated than in the bouillon media.

The Change in Urinary Constituents following the Feeding of B. Coli Communis: Arthur Knudson and A. R. Rose.

The dogs were kept on a basal ration for long periods. This ration consisted, in part, of a fixed amount of bouillon which was inoculated at stated intervals with *B. Coli communis*. There was a rapid increase of indican and etherial sulfur eliminated in the urine following the inoculation of the bouillon, but these gradually decreased for a period of 2 to 3 weeks to the status of the normal periods, though *B. Coli* was still introduced. After a period of rest from *B. Coli*, the inoculation again produced an increase in these two constituents in the urine of the dogs, with the same gradual decrease. Other changes were noted.

The Analysis of the Urine as a Part of the Physical Examination of the College Student: G. O. Higley, E. T. Lowrey and C. T. J. Dodge.

This work was begun in September, 1915. From the urine voided by the student at the close of the physical examination a sample was taken and tested for albumen and dextrose and, in some cases, for other pathological substances. If any such substance was found, the student was advised to consult a physician. Also, the student's urine was reexamined twice, at intervals of a month or so, if found necessary.

Of 426 students who took the test, the urine of 15 showed albumin in two successive tests, and 5 showed sugar. A strong test for bile was obtained in one case. This work will be continued next year.

Plant Immuno-Chemistry: R. W. Thatcher.

The question as to whether there is in plants a series of phenomena comparable to those of antibodies in animals has not yet been settled, but is now being investigated. Two general methods of investigation are being employed: (*a*) a comparative biochemical study of the composition of healthy and diseased plants, and (*b*) a biochemical and microchemical study of the reactions produced in the host by the growing parasite. Sufficient progress has been made to justify the recognition of two types of resistance, or immunity; (*a*) an antagonism of the tissue substances of the infected plant to the action of the enzymes or other agents excreted by the growing hyphæ of the parasite, and (*b*) a hyper-sensitiveness of the host, whereby its tissues at the point of entrance of the

[2] *J. Chem. Soc.*, 79 [1], 610–28.

parasite are killed and no longer supply nutrient material for the latter, thereby causing its death by starvation.

The Presence and Origin of Volatile Fatty Acids in Soils: E. H. WALTERS.

In a recent examination of a sample of Susquehanna sandy loam soil from Texas acetic acid and propionic acid have been isolated and identified. The soil was found to contain approximately 41 parts per million of acetic acid and 13 parts per million of propionic acid.

In determining the kinds and amounts of volatile acids produced during the decomposition of green manure it was found that 98.5 c.c. *N*/10 acetic acid and 49.5 c.c. *N*/10 propionic acid were produced from 100 grams of rye when this amount of finely ground material was mixed with one kilogram of soil and allowed to decompose for six months under optimum moisture conditions in a loosely covered jar. During the decomposition of alfalfa under similar conditions it was found that 44.6 c.c. *N*/10 acetic acid and 35.4 c.c. *N*/10 propionic acid were produced from 100 grams. Methods used in the isolation and estimation of these acids are described in detail.

On the Reaction of the Pancreas and other Organs: J. H. LONG AND F. FENGER.

These investigations are in part a continuation of those reported at the Seattle meeting. In a large number of qualitative tests it was found that the pancreas "press juice," obtained by centrifugal action, is constantly acid in the organs of hogs, beef and sheep. The P_H values, the hydrogen coefficient or potential, were found to vary within narrow limits, 5.5 to 5.7.

The livers of a number of animals and the press juice from the parotid glands of cattle were likewise found acid. An acid reaction was recognized also in the juice of the spleen of hogs, but the liquid from the thyroid was practically neutral. Some explanation of the possible reason for this variation in reaction is discussed.

The pancreas reaction is undoubtedly an important physiological phenomenon and the source of the acidity was found to lie in two directions. A complete quantitative analysis of the salts in the press juice shows that they consist largely of alkali phosphates, with potassium acid phosphate in largest amount. A combination of the various ions determined discloses the fact that the solution must have an acid behavior. Another source of acid reaction is found in the character of the nucleo-proteins present. Among these the α-proteid of Hammarsten is probably the most important.

Contributions of Chemistry to the Science and Art of Medicine: L. J. DESHA.

The fundamental relationship between chemistry and medicine is emphasized by a résumé of chemical contributions to progress in physiology, pathology, therapeutics, diagnosis, etc. Such contributions will be increased by providing more men adequately trained in both chemistry and medicine. The question is raised as to the feasibility of providing for regularly trained chemists a special one- or two-year course in those branches of medicine most intimately related to chemistry. A field for such men exists in teaching the new medical chemistry, in research, and particularly in the widening applications of quantitative methods in diagnosis.

Chemical Aids in Diagnosis. I. A Comparative Study of the Tests of Renal Function: L. J. DESHA.

A preliminary report is made including the data on thirty-six cases in which the Hedinger-Schlayer-Mosenthal test diet has been used. The normal standards and diagnostic advantages set forth by Mosenthal are in general confirmed. The Greenwald precipitation of the blood proteins has been successfully employed. Most cases with established nephritis show increased nonprotein nitrogen in the blood, but there appears no close relationship between this value and prospective fatal termination. The work is being continued to include the Ambard and other tests.

Oxalic Acid and its Salts in Foods and Spices: ARNO VIEHOEVER AND JOSEPH F. CLEVENGER.[3]

Information is given as to the presence and distribution of oxalic acid and its salts in foods and spices. Some of the data are taken from literature and some are the results of a special microscopical and microchemical investigation.

Oxalic acid is present in many of our daily foods, usually in the form of calcium oxalate. Very small amounts of oxalic acid have been reported in potatoes, cabbage and pickles, where its presence was not detected microscopically by us. No calcium oxalate has been found so far in peas, carrots, parsnips, kale, cranberries or any of the cereals.

A new specific microchemical reaction with resorcin sulphuric acid was applied.

On Some Proteins from the Jack Bean, Canavalia ensiformis: CARL O. JOHNS AND D. BREESE JONES.

When meal made from the Jack bean was extracted with 10 per cent. sodium chloride about 10

[3] Contribution from the Pharmacognosy Laboratory, Bureau of Chemistry, Washington, D. C.

per cent. of globulin was obtained by dialyzing the extract. This globulin was composed of two proteins which may be separated by fractional precipitation with ammonium sulphate. These are designated globulin A and globulin B. Globulin A was present in very small amount and gave the following figures: C = 53.35, H = 6.95, N = 16.62, S = 0.81, O = 22.27. Globulin B, which was the chief protein present, gave the following percentages: C = 53.21, H = 7.02, N = 16.77, S = 0.51, O = 22.49. The nitrogen in globulin B was distributed as follows: Humin nitrogen 0.30, amide nitrogen 1.40, basic nitrogen 3.17, non-basic nitrogen 11.53, total nitrogen 16.40.

An albumin of the legumelin type was also obtained from the Jack bean. This gave the following figures: C = 53.23, H = 6.99, N = 16.30, S = 0.87, O = 22.61. The nitrogen was distributed as follows: Humin nitrogen 0.23, amide nitrogen 1.16, basic nitrogen 3.73, non-basic nitrogen 11.18, total nitrogen 16.30.

On an Alcohol-Soluble Protein from Kafir-Corn, Andropogon sorghum: Carl O. Johns and J. F. Brewster.

About three per cent. of an alcohol-soluble protein was obtained by extracting kafir-corn meal with hot 70 per cent. alcohol. The purified protein gave the following percentages:

C = 55.41, H = 7.25, N = 16.38, S = 0.62, O = 20.34

The nitrogen distribution calculated from a Van Slyke analysis was as follows:

Humin nitrogen	0.17
Amide nitrogen	3.46
Basic nitrogen	1.04
Non-basic nitrogen	11.97
Total nitrogen	16.64

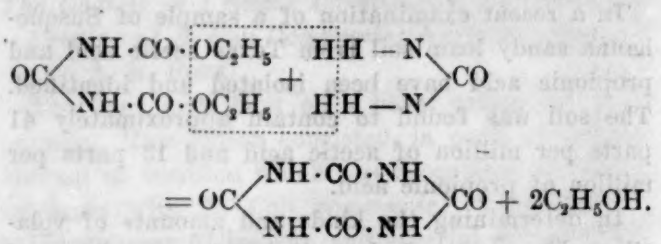
The distribution of the basic nitrogen, calculated to the per cent. of amino acids in the proteins, was as follows:

Arginin	1.58
Lysin	0.90
Cystin	0.78
Histidin	1.00
Tryptophan present.	

While this protein resembles zein from maize in its ultimate composition, it differs from zein which is lacking in lysin and tryptophan. Further investigations are in progress.

A Synthesis of Tetracarbonimid: David E. Worrall and Marion K. McNamara.

The oxidation of uric acid by hydrogen peroxide in alkaline solution results in the formation of tetracarbonimid. This substance has been synthesized in this laboratory by heating, in alcoholic solutions, molecular amounts of carbonyl dimethan and urea. The two substances slowly combine with the elimination of two molecules of alcohol



A Chemical and Bacteriological Study of some Non-Pathological Gastric Residuums: Chester C. Fowler, Max Levine and Sue B. More.

The contents of forty fasting human stomachs free from gastric symptoms were examined for free and total acid, pepsin, trypsin and bile. The volumes and physical characteristics were noted and the number and kinds of organisms determined by plating on wort agar and plain and glucose agar.

The stomachs fall into three groups: (*a*) practically sterile, (*b*) containing less than 2,000 organisms per c.c., (*c*) containing more than 4,000 per c.c.

There were three main groups of yeasts, (1) not producing gas from substance tested, (2) forming gas from glucose, fructose and galactose, (3) forming gas from these mono-saccharides and maltose.

Many of these yeasts formed acetyl-methyl-carbinol ($CH_3CHOH \cdot CO \cdot CH_3$).

A Study of Eighty Samples of Gastric Residuums obtained from Apparently Normal Women: Chester C. Fowler and Zelma Zentmire.

Sixty women were the subjects of this experiment. Twenty-one submitted to the collection of samples a second time; making a total of eighty-one samples.

The determinations made were: total and free acid, pepsin and trypsin.

The averages obtained were: volume 49.44 c.c., total acid 30.31 c.c. (*N*/10 alkali to neutralize 100 c.c. of juice), free acid 15.63 c.c., pepsin 3.32, and trypsin 5.22.

A marked constancy in the residuum of the same individual at different times was noted. In general the results of Fowler, Rehfuss and Hawk obtained on men at Philadelphia were confirmed.

Charles L. Parsons,
Secretary

(*To be continued*)